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Quantification of Landscape Structure Within the Land Condition-Trend Analysis Monitoring Program at Camp Williams, Utah

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QUANTIFICATION OF LANDSCAPE STRUCTURE WITHIN THE
LAND CONDITION-TREND ANALYSIS MONITORING
PROGRAM AT CAMP WILLIAMS, UTAH

by

Lorraine Munguía

A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

in

Range Science

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Logan, Utah
1996
ABSTRACT

Quantification of Landscape Structure Within the Land Condition-Trend Analysis Monitoring Program at Camp Williams, Utah

by

Lorraine Munguía, Master of Science
Utah State University, 1996

Major Professor: Dr. Neil E. West
Department: Rangeland Resources

The Land Condition-Trend Analysis (LCTA) program was developed by the U.S. Army to assist in the sustainable management of natural resources on U.S. Army lands. The LCTA program applies a standardized procedure in order to select long-term monitoring sites. The LCTA monitoring program was applied to Camp Williams, a National Army Guard training site located in central Utah. Due to the criteria set by the LCTA monitoring program, 61 percent of Camp Williams was explicitly excluded from the LCTA monitoring protocol because it appeared to be more heterogeneous, which would make it difficult to locate monitoring sites in the field.

This study compared the monitored landscape with the unmonitored landscape to determine how the two landscapes differed. The expectation was that the monitored landscape would contain larger, less numerous patches compared with the unmonitored landscape, which was expected to contain smaller, more numerous patches. Accordingly,
the landscape structures of the included and excluded lands were compared. The landscape metrics utilized to quantify landscape structure were largest patch index (percent), number of patches, patch density (#/100 ha), mean patch size (ha), double log fractal dimension, Simpson’s diversity index, Simpson’s evenness index, interspersion (percent), and contagion. Small differences did occur between the two landscapes, though the population variance showed that the two landscapes were more alike than different for all metrics, except interspersion and contagion which did show small differences. Due to the criteria set by the LCTA monitoring program, these results were not expected. Since it was shown for the majority of landscape metrics that the two landscapes were more alike than different, the 61 percent of Camp Williams excluded from monitoring consideration was not greatly different. However, important features such as riparian areas and recent small burns were largely contained within the areas excluded by the LCTA program. Further investigation of landscape metrics is encouraged because previously unmonitored features of wildlands can only be assessed by examination of these coarse-scale characteristics.
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Lorraine Munguía
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CHAPTER I

INTRODUCTION

Considering the landscape approach

There is a constant flux of knowledge and paradigms on how to manage our rangelands. Ecosystem management (EM) is dominating current thought as a new framework for managing rangelands (Kessler et al. 1992). In the past, attaining knowledge about natural processes was accomplished via a reductionistic approach. That approach studies natural processes within a small-scale, controlled environment, and then attempts to extrapolate the results of such studies to the landscape. However, relationships observed on small portions may not always apply to the complex landscape or vice versa.

The EM approach is concerned with understanding the whole, and not just the parts that make up the whole. Also, unlike a reductionistic view, an EM approach addresses the need to confront natural resource issues from larger temporal and spatial scales. Fortunately, current technological advances such as remote sensing (RS) and geographic information systems (GIS) can contribute to understanding multiple temporal and spatial scales of natural processes. LANDSAT imagery in particular provides the capability for frequent landscape assessment over large areas (Foran 1986), and with GIS, spatial relationships at a landscape level can be easily portrayed. An importance component of EM is the necessity for monitoring. The Committee on Rangeland Classification (1994, p.12) stated the following:
Monitoring assists in the ability to assess the health of federal and nonfederal rangelands and can judge whether current management practices are adequately sustaining the rangeland's capacity to satisfy values and produce commodities.

In order to understand how a landscape is responding to certain management decisions, appropriate, well designed monitoring approaches are paramount. Kessler et al. (1992) wrote, "The concept of learning from management experience provides a process for adjusting management in response to results provided by the research and monitoring framework."

In applying EM, not only is it essential to monitor population and community level information, it is important to consider landscapes in monitoring. Although, in the past, available tools only allowed for the monitoring of population and community phenomenon, today, RS and GIS have given the natural resource manager the ability to monitor the landscape, as well.

The knowledge that RS could be utilized to study the landscape is not a recent view point. Johnson (1969, p.2) noted, "Remote sensing promises to bridge the gap between ecological research and the better planning and management of landscapes."

Over 20 years later, Allen and Hoekstra (1992) remarked that remote sensing has allowed the landscape ecologist to move upscale, by giving the landscape ecologist the tools for analyzing landscape ecological relationships. Turner and Gardner (1991, p.5), in the first major handbook of methods, stated:

**Broad scale indices of landscape structure may provide an important metric for monitoring regional ecological changes. Such applications are of particular importance because changes in broad-scale patterns (e.g., in response to global change) can be measured with remote-sensing**
technology, and an understanding of the pattern-process relationship will allow functional changes to be inferred.

The attempt to incorporate landscape-level monitoring approaches into the management of natural resources is fairly recent, and as a result, only the research community has begun to explore the possibilities. Consequently, the management of natural resources, especially as it pertains to monitoring, is currently utilizing our understanding of community or population ecology as opposed to incorporating a landscape ecological approach.

An example of this is with the Land Condition-Trend Analysis (LCTA) monitoring program, developed by the U.S. Army. The LCTA program, a contemporary approach to monitoring natural resources on military reserves, applies RS and GIS. The monitoring program's major objective is to assist in the sustainable management of natural resources in order to support the training and testing missions of the U.S. Army (Diersing et al. 1988). The monitoring is accomplished solely at the community level; however, important changes may be occurring at a larger scale that may not be detected at the community scale.

The Land Condition-Trend Analysis monitoring program

The U.S. Army is responsible for managing over 4.8 million ha of land for military use. The U.S. Army is concerned with maintaining the long-term integrity of land and resource conditions in order to support the training and testing missions of army lands (Blackburn et al. 1990). The U.S. Army has also been called upon to comply with
environmental regulations, because the natural resource amenities occurring on U.S. Army land has attracted greater public scrutiny compared with the past. Thus, conservation of natural resources has become a high priority to the U.S. (Anonymous 1994). In response to the demands placed on the U.S. Army to better manage their lands, they have utilized RS and GIS to develop the LCTA monitoring program. The major objectives of this program are described below.

The program was developed at the U.S. Army Construction Engineering Research Laboratory (USA CERL) under the principles of sustained yield and multiple use of training lands. The overall goals of the LCTA Program are (Tazik et al. 1992, p.1):

(1) evaluate the capability of land to meet the multiple-use demands of the U.S. Army on a sustained basis.
(2) monitor and evaluate changes in natural resources relative to current land uses.
(3) delineate the biophysical and regulatory constraints to use of the land.
(4) serve as a basis for amending land management plans to ensure long-term resource availability.
(5) implement standardized data collection, analysis, and reporting procedures that enable compilation and evaluation of data and other information on an army-wide basis, and
(6) characterize the flora and fauna on army installations.

The hope is that the program can address most resource information needs and unique natural resource problems occurring on U.S. Army lands (Tazik et al. 1992). The program attempts to identify problems before damage becomes irreversible, and thus allow for the activation of alternative management plans.
Techniques used for the LCTA monitoring program

The LCTA program uses remotely sensed imagery recorded by the French SPOT (Système Probatoire pour l'Observation de la Terre) satellite to stratify its sampling. The satellite images are obtained during peak plant growth (Diersing et al. 1992). Statistical spectral clusters derived from the satellite imagery using an unsupervised classification are overlaid on soil mapping units of the installation. Combinations of the spectral clusters overlaid on the soil mapping units resulting in polygons less than 2 ha in size are ignored because of the difficulty in identifying areas this small in the field (Diersing et al. 1992). Finally, inventory sites are assigned in a stratified random fashion to the areas represented by the unique spectral clusters/soil mapping unit combinations of greater than 2 ha in size. During the field season these inventory sites are located, and data are collected to create baseline information. This is repeated over successive years to monitor changes.

Warren et al. (1990, p.333) stated, “The LCTA program employs an objective procedure to select sites for field sampling and verification of multispectral classification categories.” As well, the procedure utilizes GIS technology and a priori incorporation of ancillary data to maximize the representativeness of field sample sites (Warren et al. 1990). The LCTA approach focuses entirely on community criteria at sampling points and does not attempt to monitor synoptic changes occurring within landscapes. Because polygons less than 2 ha in size are not considered for monitoring, possibly important features of the landscape are going unmonitored. These possibly important features of the
landscape are the areas consisting of a mosaic of patches ("salt and pepper" areas) and long, thin, linear patterns. Such areas of high landscape diversity can be considered as ecotonal and are usually important for maintaining total species richness. While the LCTA approach attempts to sample representative communities, potentially important components of the landscape are completely excluded from monitoring. Thus, elements of biodiversity being impacted by U.S. Army activity could be missed.

Landscape-level information could assist the land manager in making critical decisions. Landscape features, such as patch area, have been shown to correlate strongly with species diversity (Turner and Gardner 1991). Hence, an important land management issue like maintaining species diversity of an area may be better resolved with landscape-level knowledge. Thus, it is the goal of this study to test the incorporation of landscape metrics into the LCTA monitoring program.

**Study area**

Camp Williams (CW) is a National Guard Training Site, operated by the Utah Army National Guard. It covers 11,340 ha and is located 42 kilometers south of Salt Lake City, 35 kilometers miles northwest of Provo, and 8 kilometers northwest of Lehi, UT. The reserve straddles the Salt Lake and Utah County boundaries along the crest of the western part of the Traverse Mountains, adjoining the Oquirrh Mountains. A small portion of the Jordan River runs along the eastern perimeter of the reserve.

The average annual temperature at CW can range from 4.5 °C to 12.2 °C, depending on ecological site. Similarly, the average annual precipitation is 381 to 635
millimeters depending upon ecological site (Soil Conservation Service 1974). The average frost-free season ranges from 60 to 180 days. The native vegetation is dominated by bunch grasses, bitterbrush, oakbrush, big sagebrush, and some juniper. Elevation ranges from 1,373 to 2,135 m. The topography is predominantly mountainous.

The rocks on CW are predominantly brecciated and faulted quartzite and limestone of the Pennsylvanian Oquirrh Formation, and Tertiary latite and andesite flows and tuffaceous strata of the Salt Lake Group (Stokes 1986). Recent alluvial deposits occur on low slopes on the southern boundary, and Pleistocene Lake Bonneville deposits cover the east and northeast installation boundaries (Stokes 1986).

Landuse

Camp Williams was declared a federal military reservation in 1914, but was used for encampments as early as 1854. Training facilities at CW include weapons firing ranges, heliports, a combat assault landing strip, an airborne facility, wash racks, and rappelling towers. The primary mission of CW is to provide annual and weekend training facilities for Utah Army National Guard units.

Non-military uses occur at CW. Presently, unmonitored use by cattle and sheep grazing occurs on the reserve. There exists a large mule deer population on the reserve; as a result, illegal hunting does occur at CW.

Objectives

At CW the LCTA monitoring program identified polygons satisfying a given standard and then sampled community-level information from a quadrat existing within
the chosen polygon (Anonymous 1994). The plant community existing within the
quadrat was assumed to be representative of that polygon. The major objective of this
study was to incorporate landscape metrics into the LCTA monitoring program applied to
CW. This was accomplished by comparing the landscape excluded by the LCTA
monitoring program (non-LCTA landscape)---about half of CW---with the landscape
monitored by the LCTA program (LCTA landscape).
CHAPTER 2
LITERATURE REVIEW

Introduction

Since the 19th century, an awareness of civilization's power to change and destroy
the biological world has grown (Botkin 1990). In the past, anthropogenic impacts upon
nature were mostly viewed from a local level and within small temporal scales. Today,
there exists an understanding that man is changing nature at larger scales (Riitters et al.
1995). As a result, an interest in the spatial-temporal scales at which the dynamics of
natural systems operate has grown. A product of this growing interest is the emergence
of landscape ecology. Landscape ecology focuses upon spatial and temporal patterns
across landscapes and examines the development and dynamics of spatial heterogeneity
and its influence on biotic and abiotic processes (Turner 1987).

Landscape ecology's role

The importance of landscape ecology in managing our natural resources has
grown over the past decade. Noss (1983) observed that in particularly heterogeneous
regions, the landscape level may be a more appropriate unit to study and manage
compared to focusing on single sites or ecosystems. He views the interconnections
among the patches in a landscape at least as significant to the maintenance of diversity as
the size of the patches. Also, the landscape approach identifies patterns that might
otherwise go unnoticed (Noss 1983). A landscape approach combines the spatial
attributes of ecosystem behavior with human activities affecting the spatial pattern of the
movement of energy and material at the landscape level (Risser 1985). In order to
preserve the greatest possible amount of our natural heritage of biological diversity, it is
necessary to understand how human disturbance affects natural communities at the
landscape level (Loehle and Wein 1994). Naveh (1987, p.77) asserted:

The readiness of human society to apply ecological knowledge and wisdom in
land use is lagging far behind its technological skills in exploiting these functions
for short-term economic benefits. For this reason, the study of the
interrelationships between landscape functions and land use patterns is not only of
basic scientific interest, but also of great practical importance.

The importance of scale

The effects of spatial and temporal scale must be considered in landscape ecology
(Meentemeyer and Box 1987; Milne et al. 1989; Turner et al. 1989a; Urban et al. 1987),
as spatial scaling is vitally important to the ecologist (O'Neill et al. 1986). All ecological
processes and types of ecological structure are multiscaled in both time and space (Allen
and Hoekstra 1991; Allen and Hoekstra 1992; Baker 1989; Meentemeyer and Box 1987;
Milne 1992; O'Neill et al. 1986; O'Neill et al. 1991b; Turner 1989; Turner et al. 1989a;
Turner et al. 1989b; Wiens 1989; Wiens and Milne 1989). For example, ecological
processes occur from square millimeters to hundreds of square kilometers and from time
scales of minutes to millennia (Risser 1987). It is the mixture of ecological processes
consisting of different spatial and temporal scales, all operating as a system, that leads to
the ideas of landscape ecology (Risser 1987).

The scale at which a study is conducted is important to understand since
ecological processes occur across different scales (Turner 1989). Naveh (1994) wrote
that a more human scale should be emphasized. He argued that not only should the bioecological aspects of landscape heterogeneity be considered for study, but the human ecological, cultural, and perceptional aspects of landscape heterogeneity should also be considered. Naveh (1994) does not consider humans to be external disturbance factors, but as interacting coevolutionary ecosystem components. It is the interrelationships between ecological, socioeconomic, and cultural factors that influence landscape heterogeneity (Naveh 1987; Naveh 1994; Naveh and Lieberman 1990).

Wiens (1985, 1992) has argued, however, that the scale at which we study landscape ecology is too human-centered. Humans usually view structure on different scales than an aphid or ant. He has suggested that adopting an organism-centered view of the environment is necessary in understanding important patch structure or dynamics (Wiens 1985). Karr (1994) supports this viewpoint, but adds that the scale for a study should not only be determined by the organisms, but by the questions under investigation.

**Hierarchy theory in landscape ecology**

Due to scaling issues, the hierarchy theory has been introduced as a useful framework for ordering scale complexities (Allen and Hoekstra 1992; Allen and Starr 1982; O'Neill 1989). O'Neill et al. 1986 contend that when approaching scientific questions, the focus should be on a specific spatio-temporal scale of observation (O'Neill et al. 1986). When extrapolating from a specific observation set to other scales of observation, problems arise, since one specific observation set is not optimal or absolute (O'Neill et al. 1986). Rather, the specific phenomena under investigation are set by the
purpose of the study. If the purpose changes, so does the appropriate spatial and temporal extent of the system. This theory supports the focus of a particular level of interest, in which the investigator must pay attention to the spatial and temporal scales on which the phenomena of interest are occurring. The temporal and spatial scale must be taken into account when designing experiments or land management actions. Allen and Hoekstra (1992, p.8) termed this "criteria for observation" and noted the following:

Criteria are the basis upon which one makes a decision as to what relationships are important in an ecological observation....Scaling is done by the observer; it is not a matter of nature independent of observation.... Levels emerge from the interaction between decisions of the observer and the part of the universe observed.

**Spatial and temporal heterogeneity in landscapes**

Understanding heterogeneity in landscape ecology is as important as understanding scale. Landscape heterogeneity is defined by Risser (1987) as the dissimilar or diverse components or elements making up the landscape. Spatial heterogeneity results from the interactions between the spatial distribution of environmental constraints and the differential responses of organisms to the constraints (Milne 1991). Spatial heterogeneity may vary continuously with spatial scale (Kotlia and Wiens 1990; Mandelbrot 1983; O'Neill et al. 1991a; Pickett and Cadenasso 1995, Senft et al. 1987; Wiens 1989; Wiens and Milne 1989). An example of this is the spatial patterns resulting from fire disturbance compared with the spatial patterns resulting from activities such as digging and burrowing by animals (Pickett and Cadenasso 1995).

The landscape is also temporally heterogeneous, that is, ecological processes
operate at different time scales (Romme 1982; Romme and Knight 1982). An example of this is with the long life span of forest trees compared with the ephemeral life span of annual crops.

Historically, ecology considered spatial heterogeneity as an unwelcome complication or a necessary evil, although Pickett and Cadenasso (1995) have written that landscape ecology considers spatial heterogeneity as a main causal factor in ecological systems. This spatial and temporal heterogeneity makes it difficult to extrapolate from data collected at small scales to larger scales (Johnson 1990).

Spatial and temporal heterogeneity are affected by ecological processes (Castello et al. 1995; Peterjohn and Correll 1984; Risser 1990; Romme 1982; Romme and Knight 1982; Turner and Romme 1994). A major goal in landscape ecological study is to understand how heterogeneity influences the biotic and abiotic processes (Risser 1987).

As described above, landscapes are spatially heterogeneous areas (i.e., environmental mosaics). As a result, the structure, function, and change of landscapes are scale-dependent (Turner 1989). With this understanding, these basic components making up the landscape mosaic are discussed below.

**Landscape structure, function, and change**

Forman and Godron (1986) defined the fundamental characteristics of landscapes as possessing qualities of structure, function, and change. Structure is the spatial relationships among distinctive ecosystems. Patches are the building blocks of a landscape or make up the structure of a landscape (Risser 1987). The impact on the
landscape by humans has resulted in a landscape structure consisting of a mixture of natural and human-managed patches that vary in size, shape, and arrangement (Forman and Godron 1986; Forman and Godron 1981; Krummel et al. 1987; Turner and Ruscher 1988). Function involves the interactions among the spatial elements or the flow of energy, materials, and species among the component ecosystems. Change is the alteration of structure and function of the ecological mosaic over time (Forman and Godron 1986).

**Landscape structure**

Landscape pattern is understood by quantifying the landscape structure, that is, size, shape, biotic type, number, and configuration of patches (Forman and Godron 1986). Many studies have attempted to quantify landscape structure. Quantifying landscape structure is necessary in order to compare different landscapes, identify significant changes through time, and relate landscape patterns to ecological function (Turner 1989).

In a study located in the subalpine portion of Yellowstone National Park, indices of richness, evenness, and patchiness were calculated. These metrics were then related to the fire history of the site since 1600 A.D. (Romme 1982; Romme and Knight 1982). The results from this study suggest that Yellowstone Park is a non-steady-state system, where long-term cyclic changes in landscape composition and diversity result.

Turner and Ruscher (1988) utilized landscape measurements to study the human land-use patterns in Georgia. Their study showed a general trend of decreasing landscape diversity from the mountains to the coastal plain of Georgia.

O'Neil et al. 1988 used three landscape indices, dominance, contagion, and
fractal dimension, in the eastern United States. These indices discriminated between major landscape types, such as urban coastal, mountain forest, and agricultural areas.

Riitters et al. 1995 studied a set of landscape metrics for monitoring landscape condition in terms of land use pattern and structure. This study concluded that six univariate metrics, average perimeter-area ratio, contagion, standardized patch shape, patch perimeter-area scaling, number of attribute classes, and large-patch density-area scaling, may be useful in monitoring landscape condition relative to land use pattern and structure.

Turner (1990) applied a spatial analysis program (SPAN) to quantify landscape patterns and their changes. SPAN calculates landscapes metrics such as fractal dimension, contagion, dominance, a diversity index, proportion of the landscape occupied by each category, size and perimeter of each patch, edges between each pair of categories, and probabilities of adjacency (Turner 1990). Turner (1990) showed that simple indices and measures can capture features of landscape pattern at different scales and significant changes in landscape patterns can be detected through time.

Hoover and Parker (1991) used traditional measures of species diversity and spatially explicit measures of landscape diversity to compare the biotic diversity in six landscapes across Georgia. Also, this study showed that species diversity measurements did not closely correspond with landscape diversity measurements, showing that the measures of biotic diversity used are scale-dependent (Hoover and Parker 1991).

McGarigal and McComb (1995) investigated the relationship between landscape structure and breeding bird abundance in the central Oregon Coast Range. Vegetation
and birds in 30 landscapes (250-300 ha) were sampled. They computed a variety of landscape metrics from digital vegetation cover maps. In their study they concluded that species abundances were greater in the more heterogeneous landscapes.

Shapes have been quantified by using fractal geometry, which provides a measure of complexity of the spatial patterns (Turner et al. 1989b). Mandelbrot (1977, 1983) introduced fractal geometry as a method to study shapes that are partially correlated over many scales.

Krummell et al. 1987, O'Neill et al. 1988, and Turner and Ruscher (1988) used fractals to compare the geometry of different landscapes. These studies suggested that human-influenced landscapes display simpler patterns compared with natural landscapes.

Wiens and Milne (1989) measured the patterns of beetle landscapes and beetle movements in a semiarid grassland in the Sevilleta National Wildlife Refuge in New Mexico. They showed a significant tendency of beetles to avoid areas with distinct fractal dimensions. They showed how landscape structure modified beetle movements in heterogeneous landscapes (Wiens and Milne 1989).

With (1994) utilized a fractal analysis of movement patterns to identify the scales at which organisms are interacting with the patch structure of the landscape. This analysis showed significant differences in the fractal dimension of movement patterns of two species and suggested that the two species may be interacting with the patch structure at different scales. Here fractal analysis compared the landscape perceptions of different species within the same environment.
Palmer (1988) used fractal geometry for describing spatial patterns of plant communities. The fractal dimensions resulting from this study suggested a weak spatial dependence and patterns of spatial variation at one scale cannot be reliably extrapolated to other scales (Palmer 1988).

The grazing patterns of white-tailed deer and Spanish goats were studied in southern Texas using a fractal dimension (Owens et al. 1996). The grazing paths were represented as fractals showing the tortuosity of the animal movements. The study showed that in the same pastures, white-tailed deer grazing paths were significantly different from the path of Spanish goats.

Loehle (1990) used a fractal approach to quantify animal movement patterns. This approach captured detail that would have otherwise been lost had the traditional method for describing home range been applied (Loehle 1990).

**Landscape function**


An example of how landscape patterns have influenced processes can be found in Peterjohn and Correll (1984). They studied the concentrations of nutrients (carbon, nitrogen, and phosphorus) in surface runoff and shallow groundwater in an agricultural watershed that contained both cropland and riparian forest (Peterjohn and Correll 1984).
Their study showed that without the riparian forest, twice as much nitrate nitrogen would have been lost to the stream.

Ludwig and Tongway (1995) found that in Australian semiarid woodlands, landscape patches at all scales functioned to capture and retain scarce resources, rather than these resources being lost from the system. All scales of patches, ranging from grass clumps to larger woodlands, served an important function/resource regulators. They concluded that in order to prevent the degradation of semiarid woodland landscape, a full range of large- to small-scale patches should be maintained (Ludwig and Tongway 1995).

Romme (1982) described how changes in landscape patterns influence a variety of natural features such as wildlife, water and nutrient flow and the probability of different kinds of natural disturbance. For example, he found that mature coniferous forest stands in Yellowstone National Park are generally most susceptible to fire, whereas younger forests are least susceptible.

Landscape patterns not only affect ecological processes, landscape processes can influence landscape patterns (Risser 1990). An example of this discussed by Castillo et al. (1995). They described how pathogens regulate, and in turn are regulated by, patterns and processes in forest ecosystems. They also concluded that pathogens affect forested landscapes primarily through tree mortality or reduced competitive ability and it is landscape pattern that promotes disease development.

Landscape heterogeneity may enhance or inhibit the spread of disturbance (Pickett and White 1985). Turner and Romme (1994) observed that there is a two-way interaction between crown fires and the spatial patterning of a landscape. Broad-scale patterns in
vegetation are created by crown fires by producing a patch mosaic of stand age classes; however, spatial patterns in terrain and fuel across the landscape may constrain the spread and behavior of crown fires (Turner and Romme 1994).

Spatial patterning and changes in landscape structure (e.g., habitat fragmentation) influence the distribution, movement, and persistence of species (Turner 1989). Milne et al. (1989) studied the effects of landscape fragmentation on the wintering areas of white-tailed deer. This study demonstrated that sites containing suitable habitat, but isolated from other suitable patches, were not used by the deer (Milne et al. 1989).

Weins et al. (1993) described how a the pattern of Scandinavian boreal forest influences the movement of a vole. The movement of a vole through the landscape is influenced by local habitat patches, and by the locational relationship of the patches within a mosaic—the sizes, shapes, arrangement, and connectedness (Wiens et al. 1993).

**Landscape change**

Landscapes change over time, but landscape processes do not occur simultaneously or at the same rate (Risser 1987). Change in landscape heterogeneity is affected by a number of processes (Forman and Godron 1986). Geomorphic processes occurring over long time periods influence landscape heterogeneity. Colonization patterns of organisms occurring over short and long time-scales shape landscape heterogeneity. Local disturbances of individual ecosystems over short time periods influence landscape heterogeneity. Most importantly, the natural land cover has been changed by human activities such as urbanization, agriculture, and forestry, where the
natural vegetation has been replaced by managed systems of altered structure (Krummel et al. 1987). It is not yet generally understood if the heterogeneity observed in the landscape has resulted from environmental factors, past disturbances, or both. It is the understanding of the interplay of environment and history that will be a major challenge for landscape ecology (Pickett and White 1985).
CHAPTER 3
METHODS

Introduction

The discipline of landscape ecology acknowledges that patterning of landscape elements or patches greatly influences ecological processes (McGarigal and Marks 1995). Patches are the building blocks of a landscape or make up the structure of a landscape (Risser 1987). In quantifying landscape structure, landscape function and change can be studied (McGarigal and Marks 1995).

In this study, the landscape elements (patches) measured consisted of 30 x 30 m pixels or cells; thus, the size of the individual units (grain) of investigation was no smaller than 30 x 30 m. This is a coarser spatial resolution compared with that seen directly at ground level. Aerial photography, also, contains a much finer spatial resolution compared with that of satellite imagery. For example, the spatial resolution of the U.S. Department of Agriculture 1:20,000 black-and-white aerial photography is about 1 m (Campbell 1987). It is important to recognize that the patch must be defined relative to the phenomenon under investigation (McGarigal and Marks 1995). Here, the patches measured were associated with particular vegetation classes characterized by Van Niel (1995), who used the same 30 x 30 m scale.

In this study, the landscape structure of the LCTA landscape was compared with the non-LCTA landscape. The differences in landscape structure between these two portions of CW were quantified utilizing FRAGSTATS, which is a spatial pattern
analysis software program developed by McGarigal and Marks (1995) at Oregon State University. There are many indices that FRAGSTATS (McGarigal and Mark 1995) calculates. This study only focused on 10 indices. The landscape metrics utilized for comparison were largest patch index (percent), number of patches, patch density (#/100 ha), mean patch size (ha), patch size deviation (ha), double log fractal dimension, Simpson’s diversity index, Simpson’s evenness index, interspersion index (percent), and contagion.

**GRASS**

The data used in this project were initially retrieved utilizing the Geographical Resources Analysis Support System (GRASS), which is a public domain geographic information system developed by the U.S. Army Construction Engineering Research Laboratory (U.S. Army CERL) (Warren et al. 1990). The data were received from the U.S. Army CERL in GRASS format copied onto an 8-mm cassette tape. After the files were manipulated in GRASS, the files were ready to be imported into IMAGINE 8.0. Table 1 shows the parameters used to import the GRASS files into IMAGINE 8.0.

*Table 1. Information needed to import the GRASS files into IMAGINE 8.0.*

<table>
<thead>
<tr>
<th>Importation information</th>
<th>CW landscape (Fig. 1)</th>
<th>LCTA landscape (Fig. 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Import type</td>
<td>Generic binary data</td>
<td>Generic binary data</td>
</tr>
<tr>
<td>Data format</td>
<td>BSQ</td>
<td>BSQ</td>
</tr>
<tr>
<td>Data type</td>
<td>Unsigned 16-bit file</td>
<td>Unsigned 8-bit file</td>
</tr>
<tr>
<td>Number of rows</td>
<td>1400</td>
<td>370</td>
</tr>
<tr>
<td>Number of columns</td>
<td>2750</td>
<td>667</td>
</tr>
<tr>
<td>Number of layers</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
There were two files of interest in this project. The first file was an unsupervised classification of the entire CW landscape. An unsupervised classification is the identification of spectrally homogeneous clusters within multispectral data, which does not require extensive prior knowledge of the region of interest (Campbell 1987). This image contained statistical spectral clusters as opposed to cover classes. A cover class has been associated with some vegetation class on the ground. Spectral classes are groups of pixels that are uniform with respect to the brightnesses in their several spectral channels (Campbell 1987). The entire CW landscape can be seen in Figure 1. The CW landscape was clustered by CERL into 256 statistical spectral clusters.

The second file of interest was the landscape (LCTA landscape) considered by the LCTA monitoring program for long-term sampling (Fig. 2). The LCTA landscape consisted of nine categories. Statistical spectral clusters derived from the satellite imagery (CW landscape) were overlain on soil mapping units of the installation. Combinations of statistical spectral clusters and soil mapping units resulting in polygons less than 2 ha in size were excluded. The nine categories within the LCTA landscape were a product of this procedure, representing polygons greater than 2 ha.

**FRAGSTATS**

After the GRASS files were successfully imported into IMAGINE, analysis was conducted using FRAGSTATS 2.0, to quantify landscape structure. A raster version of the software was used for this study (McGarigal and Marks 1995). This version is a C
Fig. 1. Map of Camp Williams showing the statistical spectral clusters resulting from the unsupervised classification. The spectral clusters are made up of 256 categories, which are represented by numerous color categories derived from SPOT imagery of February 1992. White colorless areas represent intensive training areas. These areas do not show up in subsequent analysis.
Fig. 2. Landscape polygons utilized by the LCTA monitoring program to locate long-term monitoring sites.
program that accepts ASCII image files, 8- or 16-bit binary image files, Arc/Info SVF files, ERDAS image files, and IDRISI image files.

The FRAGSTATS software was obtained from Oregon State University via the internet by using a file transfer program or ftp. In order to assure that FRAGSTATS was properly functioning, the following steps were taken. First, the LCTA landscape IMAGINE format file was exported as an ERDAS version 7.5 file. This step was completed because FRAGSTATS does not accept IMAGINE image files. To run FRAGSTATS there is a single command line, consisting of several arguments, issued from the prompts as follows:

```
fragstats in_image out_file cellsize edge_dist data_type [rows] [cols]
[background] [max_classes] [weight_file] [id_image] [desc_file]
[bound_wght] [diags] [prox_dist] [nndist] [patch_stats] [class_stats].
```

These arguments are described in Table 2. The mathematical formulae used to calculate each landscape metric (i.e., double log fractal dimension) are discussed in the FRAGSTATS manual (McGarigal and Marks 1995). These mathematical formulae are described in narrative terms in Table 3.

A file containing the output indices was produced. Contained in the FRAGSTATS output file were patch indices, class indices, and landscape indices. This study was concerned mostly with landscape indices that FRAGSTATS generated as opposed to patch and class indices.

In order to verify that the FRAGSTATS calculations were consistent, a sub-sample of the LCTA landscape was created in ERDAS. Landscape metrics were generated on this sublandscape. The landscape metrics of the sublandscape were then
Table 2. Description of the arguments used to execute FRAGSTATS.

<table>
<thead>
<tr>
<th>Arguments</th>
<th>Description of arguments</th>
</tr>
</thead>
<tbody>
<tr>
<td>In_image</td>
<td>Name of input landscape file</td>
</tr>
<tr>
<td>Out_file</td>
<td>Basename for output ASCII files</td>
</tr>
<tr>
<td>Cellsizel</td>
<td>Cell size (m) in the input image (i.e., 30 m)</td>
</tr>
<tr>
<td>Edge_dist</td>
<td>Distance from patch edge (m) used to determine core area (i.e., interior habitat)</td>
</tr>
<tr>
<td>Data_type</td>
<td>The type of input image file (i.e., SVF, ASCII, eight or 16 bit binary file)</td>
</tr>
<tr>
<td>Rows</td>
<td>Number of rows in input image</td>
</tr>
<tr>
<td>Cols</td>
<td>Number of columns in input image</td>
</tr>
<tr>
<td>Background</td>
<td>The value of background cells</td>
</tr>
<tr>
<td>Maximum_classes</td>
<td>Maximum number of patch types</td>
</tr>
<tr>
<td>Weight_file</td>
<td>The name of an ASCII file containing weights for each combination of patch type</td>
</tr>
<tr>
<td>Id_image</td>
<td>The method for assigning patch ID’s to each patch in the landscape</td>
</tr>
<tr>
<td>Descriptor_file</td>
<td>The name of an ASCII file containing character descriptors for each patch type</td>
</tr>
<tr>
<td>Bound_weight</td>
<td>The method for assigning what proportion of the landscape boundary and background class will be included as edge in the metrics based on edge length</td>
</tr>
<tr>
<td>Diagonals</td>
<td>Option to choose if diagonal neighbors should be evaluated when finding the cells that make up a patch</td>
</tr>
<tr>
<td>Proximity_distance</td>
<td>The search radius into use calculating the proximity indices</td>
</tr>
<tr>
<td>Nearest neighbor distance</td>
<td>Option to choose if indices based on nearest neighbor will be calculated</td>
</tr>
<tr>
<td>Patch_statistics</td>
<td>Option to choose if patch indices should be written to the output files</td>
</tr>
<tr>
<td>Class_statistics</td>
<td>Option to choose if class indices should be written to the output files</td>
</tr>
</tbody>
</table>

compared with landscape metrics associated with the entire LCTA landscape. The
comparison between the metrics of the LCTA landscape and the sublandscape showed
Table 3. Narrative description of the landscape metric mathematical formulae.

<table>
<thead>
<tr>
<th>Landscape metrics</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total area (ha)</td>
<td>Equals the total area (m²) of the landscape, divided by 10,000 (to convert to ha)</td>
</tr>
<tr>
<td>Largest patch index (percent)</td>
<td>Equals the area (m²) of the largest patch in the landscape divided by the total landscape area (m²), multiplied by 100 (to convert to percentage)</td>
</tr>
<tr>
<td>Number of patches</td>
<td>Equals the number of patches in the landscape</td>
</tr>
<tr>
<td>Patch density (#/100 ha)</td>
<td>Equals the number of patches in the landscape divided by total landscape area, multiplied by 10,000 and 100 (to convert to 100 ha)</td>
</tr>
<tr>
<td>Mean patch size (ha)</td>
<td>Equals the total landscape area (m²), divided by the total number of patches, divided by 10,000 (to convert to ha)</td>
</tr>
<tr>
<td>Double log fractal dimension</td>
<td>Equals two divided by the slope of the regression line obtained by regressing the logarithm of patch area (m²) against the logarithm of patch perimeter (m)</td>
</tr>
<tr>
<td>Simpson’s diversity index</td>
<td>Equals one minus the sum, across all patch types, of the proportional abundance of each patch type squared</td>
</tr>
<tr>
<td>Simpson’s evenness index</td>
<td>Equals one minus the sum, across all patch types, of the proportional abundance of each patch type squared, divided by one minus one divided by the number of patch types.</td>
</tr>
<tr>
<td>Interspersion</td>
<td>Equals the minus the sum of the length (m) of each unique edge type divided by the total landscape edge (m), multiplied by the logarithm of the same quantity, summed over each unique edge type; divided by the logarithm of the number of patch types time the number of patch types minus one divided by two; multiplied by 100 (to convert to a percent).</td>
</tr>
<tr>
<td>Contagion</td>
<td>Equals minus the sum of the proportional abundance of each patch type multiplied by number of adjacencies between cells of that patch type and all other patch types, multiplied by the logarithm of the same quantity, summed over each patch type; divided by two times the logarithm of the number of patch types; multiplied by 100 (to convert to percent)</td>
</tr>
</tbody>
</table>

no differences. It was then concluded that FRAGSTATS was properly calculating consistent values for both the landscapes.
Non-LCTA landscape

All files delivered by CERL were geometrically registered one to another. With this registration, a third image file representing the excluded, or the inverse of the LCTA landscape was created. This was done by overlaying the LCTA landscape over the CW landscape. In doing so, areas where the CW landscape did not intersect with the LCTA landscape (blank areas in Fig. 2) were considered non-LCTA. These areas represented the interspaces between the elements of the LCTA landscape. The LCTA landscape file was recoded, changing all zeros to one and all non-zero numbers to zero. A third file was created by overlaying the recoded LCTA landscape file with the CW landscape. Areas that intersected with the value one were transferred to the third file. Areas that intersected with zero were not transferred. This third file (Fig. 3) representing the non-LCTA landscape consisted of many colored polygons, which represented the many excluded statistical spectral clusters.

Vegetation map

A vegetation classification map of CW, created by Van Niel (1995), was a significant source of information (Fig. 4). The imagery utilized by Van Niel to create the vegetation classification was a Thematic Mapper or TM image from July 20th of 1993. Van Niel's vegetation classification map of CW was ground truthed and determined to have an overall accuracy of 89 percent (Van Niel 1995). As mentioned earlier, both the
Fig. 3. Map showing the landscape polygons not considered for monitoring by the LCTA monitoring program. The colors represent statistical spectral clusters, resulting from the unsupervised classification.
Fig. 4. Vegetation cover type map of Camp Williams created by Van Niel (1995).
CW landscape and the LCTA landscapes were unsupervised classifications; thus, the statistical spectral clusters for both landscapes were not linked to actual vegetation classes on the ground. Because the LCTA landscape was compared with the non-LCTA landscape, knowing the vegetation classes, and not just spectral clusters, was essential for the landscape metrics generated by FRAGSTATS to be meaningful.

By utilizing Van Niel’s vegetation classification, a final LCTA landscape image (Fig. 5) file and a non-LCTA landscape image (Fig. 6) file were created. The final LCTA landscape image file was created by overlaying the LCTA landscape file with Van Niel’s vegetation classification. The LCTA landscape image file served as a template to cut out all the areas in Van Niel’s classification that were not considered for monitoring by the LCTA program. The non-LCTA landscape was created in the same way. The colored areas contained within both files represented the vegetation classes characterized by Van Niel. Figure 4 shows the color legend associated with a particular vegetation class.

Van Niel’s vegetation map contained not only all of the CW area within its boundary but also contained a 200-m buffer falling outside the CW boundary. The LCTA landscape and the non-LCTA landscape do not contain this area outside the CW boundary. In order to calculate the amount of vegetation occurring in various ground cover classes at CW, it was necessary to create a file that would contain the vegetation only occurring within CW boundary. A file in GRASS that consisted of only the outline of CW was imported into IMAGINE 8.0. Van Niel’s (1995) vegetation map was overlaid with this outline file and this resulted in a vegetation map that did not contain the 200-m
Fig. 5. Map of Camp Williams landscape showing the polygons that were utilized for the selection of long-term monitoring sites.
Fig. 6. Map of Camp Williams showing the landscape excluded by the LCTA monitoring program.
buffer falling outside the CW boundary. Table 4 shows the percent of vegetation cover classes present at CW, based on Van Niel’s vegetation classification.

**Quantifying landscape structure**

After the final LCTA and the non-LCTA landscapes were produced, the landscape structure for the two landscapes was quantified utilizing FRAGSTATS. The comparison between the landscape metrics for the two landscapes showed differences between metrics. The most obvious difference was that of area; the total LCTA-landscape area was 3,808 ha and the total non-LCTA landscape area was 5,891 ha (Table 5). Because of these varying areas, a question that arose was whether the differences observed in landscape metrics resulted from the varying areas or resulted due to actual differences in landscape structure. In order to test this, the landscapes for both files were divided into 10 equal portions. Each of the 10 portions contained the same number of pixel rows and

<table>
<thead>
<tr>
<th>Vegetation classes</th>
<th>Percent total</th>
<th>Percent of vegetation class of LCTA landscape</th>
<th>Percent of vegetation class of the non-LCTA landscape</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oak</td>
<td>22</td>
<td>20</td>
<td>23</td>
</tr>
<tr>
<td>Juniper</td>
<td>6</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Vegetated agriculture</td>
<td>0.15</td>
<td>0.01</td>
<td>0.26</td>
</tr>
<tr>
<td>Oak/sagebrush mix</td>
<td>14</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>Sagebrush</td>
<td>29</td>
<td>31</td>
<td>29</td>
</tr>
<tr>
<td>Sagebrush/grass mix</td>
<td>21</td>
<td>26</td>
<td>18</td>
</tr>
<tr>
<td>Bare/annual weeds</td>
<td>0.06</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Bare/agriculture</td>
<td>4.2</td>
<td>0.9</td>
<td>4</td>
</tr>
</tbody>
</table>
Table 5. Total amount of hectares represented by the LCTA and the non-LCTA landscape.

<table>
<thead>
<tr>
<th>Total area (ha)</th>
<th>9699 ha</th>
<th>Percentage of total area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total area sampled by the LCTA program (ha)</td>
<td>3808 ha</td>
<td>39% of CW is monitored by the LCTA program</td>
</tr>
<tr>
<td>Total area not sampled by the LCTA program</td>
<td>5891 ha</td>
<td>61% of CW is not monitored by the LCTA program</td>
</tr>
</tbody>
</table>

pixel columns (210 rows, 154 columns). It is important to note that the landscape area contained within one portion was not necessarily equal to the landscape area comprising another portion, as only the file coordinates were equal (Table 6).

FRAGSTATS generated landscape metrics for all portions. The comparison between the 10 landscape metrics for the LCTA landscape and the 10 landscape metrics for the non-LCTA landscape showed that the metrics were not equal. The landscape metrics differed as the landscape area changed for each portion; thus, it was concluded that the landscape metrics were definitely area dependent. As a result, it was necessary to compare equal areas in order that comparison of the landscape metrics be meaningful.

Since the LCTA landscape comprised 3,808 ha, while the non-LCTA landscape comprised an area of 5,891 ha, the largest landscape sampled in each was 3,808 ha. The boundary of CW was approximately rectangular in shape. Because it was important to optimize the amount of area to be measured, nested rectangular portions were first created. Geographic coordinates located in the center of each landscape were utilized as a starting point. A rectangular portion was drawn so that the midpoint of the rectangular
Table 6. Landscape metrics derived from the 10 portions, consisting of 210 rows and 154 columns each.

<table>
<thead>
<tr>
<th>Landscape metrics</th>
<th>Portion 1</th>
<th>Portion 2</th>
<th>Portion 3</th>
<th>Portion 4</th>
<th>Portion 5</th>
<th>Portion 6</th>
<th>Portion 7</th>
<th>Portion 8</th>
<th>Portion 9</th>
<th>Portion 10</th>
<th>Average</th>
<th>St. dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LCTA landscape</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total area (ha)</td>
<td>192</td>
<td>455</td>
<td>441</td>
<td>403</td>
<td>298</td>
<td>193</td>
<td>462</td>
<td>524</td>
<td>505</td>
<td>341</td>
<td>381</td>
<td>121</td>
</tr>
<tr>
<td>Largest patch index (%)</td>
<td>15</td>
<td>42</td>
<td>14</td>
<td>12</td>
<td>7</td>
<td>15</td>
<td>8</td>
<td>18</td>
<td>13</td>
<td>14</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>Number of patches</td>
<td>370</td>
<td>497</td>
<td>820</td>
<td>704</td>
<td>707</td>
<td>295</td>
<td>394</td>
<td>647</td>
<td>775</td>
<td>502</td>
<td>571</td>
<td>184</td>
</tr>
<tr>
<td>Patch density (#/100 ha)</td>
<td>192</td>
<td>109</td>
<td>186</td>
<td>175</td>
<td>237</td>
<td>153</td>
<td>85</td>
<td>123</td>
<td>153</td>
<td>147</td>
<td>156</td>
<td>44</td>
</tr>
<tr>
<td>Mean patch size (ha)</td>
<td>0.52</td>
<td>0.92</td>
<td>0.54</td>
<td>0.57</td>
<td>0.42</td>
<td>0.65</td>
<td>1.20</td>
<td>0.81</td>
<td>0.65</td>
<td>0.68</td>
<td>0.70</td>
<td>0.23</td>
</tr>
<tr>
<td>Double log fractal dimension</td>
<td>1.43</td>
<td>1.42</td>
<td>1.43</td>
<td>1.45</td>
<td>1.46</td>
<td>1.36</td>
<td>1.41</td>
<td>1.41</td>
<td>1.44</td>
<td>1.43</td>
<td>1.42</td>
<td>0.03</td>
</tr>
<tr>
<td>Simpson's diversity index</td>
<td>0.68</td>
<td>0.55</td>
<td>0.71</td>
<td>0.57</td>
<td>0.71</td>
<td>0.68</td>
<td>0.64</td>
<td>0.66</td>
<td>0.74</td>
<td>0.70</td>
<td>0.66</td>
<td>0.06</td>
</tr>
<tr>
<td>Simpson's evenness index</td>
<td>0.80</td>
<td>0.66</td>
<td>0.85</td>
<td>0.69</td>
<td>0.88</td>
<td>0.79</td>
<td>0.73</td>
<td>0.76</td>
<td>0.86</td>
<td>0.84</td>
<td>0.79</td>
<td>0.07</td>
</tr>
<tr>
<td>Interspersion index (%)</td>
<td>60</td>
<td>65</td>
<td>73</td>
<td>57</td>
<td>71</td>
<td>64</td>
<td>37</td>
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<td>537</td>
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<td>73</td>
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<td>74</td>
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</table>
portion corresponded to centrally located geographic coordinates. Seven portions were
nested on top of one another (Fig. 7). The area size contained within the first rectangular
nested portion was roughly 59.5 ha, the second portion doubled to 119 ha, the third
portion doubled to 238 ha, and so on, until the largest portion contained approximately
3808 ha for the LCTA and non-LCTA landscape.

The above was completed in IMAGINE under AOI (area of interest), where a
rectangular box of any size can be created. For each portion, an estimation was made to
determine the size the rectangular box needed to be in order to contain a given area.
After a rectangular box was created, image statistics were created for that portion of the
layer. With these data, the area values associated with each cover class were determined.
Area values were summed, and depending upon the calculated area, the rectangular
portion was made either larger or smaller. When the area contained within the
rectangular portion was equal or close to the area needed, this AOI was subsetted in
ERDAS.

Both the LCTA and the non-LCTA landscapes consisted of seven rectangular
nested portions that were all converted to ERDAS version 7.5. FRAGSTATS generated
the landscape metrics for each portion and the landscape metrics between equal area
portions were compared (Table 7). In keeping the area constant, differences between both
landscapes still existed. However, it could now be concluded that these differences
resulted from differences in landscape structure between the LCTA and the non-LCTA
landscapes, and not area, since area was held constant.
Fig. 7. Figure showing how the nested rectangular portions were applied.
### Table 7. Landscape metrics and averages associated with the nested rectangular portions.

<table>
<thead>
<tr>
<th>Landscape metrics</th>
<th>59.5 ha</th>
<th>119 ha</th>
<th>238 ha</th>
<th>476 ha</th>
<th>952 ha</th>
<th>1,904 ha</th>
<th>3,808 ha</th>
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<td>479</td>
<td>947</td>
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<td>5.9</td>
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<td>511</td>
<td>796</td>
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<td>2,695</td>
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<td>281</td>
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<td>146</td>
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<td>0.36</td>
<td>0.47</td>
<td>0.60</td>
<td>0.68</td>
<td>0.72</td>
<td>0.69</td>
</tr>
<tr>
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<td>.88</td>
<td>1.56</td>
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<td>5.88</td>
<td>4.69</td>
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<td>1.41</td>
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<td>1.43</td>
<td>1.44</td>
<td>1.43</td>
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<tr>
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<td>0.76</td>
<td>0.76</td>
<td>0.75</td>
<td>0.76</td>
<td>0.75</td>
<td>0.75</td>
<td>0.78</td>
</tr>
<tr>
<td>Simpson's evenness index</td>
<td>0.91</td>
<td>0.92</td>
<td>0.90</td>
<td>0.91</td>
<td>0.91</td>
<td>0.88</td>
<td>0.86</td>
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<td>76</td>
<td>75</td>
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<td>36</td>
<td>38</td>
<td>40</td>
<td>45</td>
<td>52</td>
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<tr>
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<td>246</td>
<td>472</td>
<td>954</td>
<td>1,951</td>
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<td>8.2</td>
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<td>0.53</td>
<td>0.51</td>
<td>0.55</td>
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<td>1.45</td>
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<td>0.79</td>
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<td>27</td>
<td>34</td>
<td>33</td>
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</table>
The next step was the placement of equal area portions throughout the landscape. It is important to note that as the area of the landscape increases, the numbers of patches increase. This increase in patches make the landscape metrics more meaningful because the basic unit used by FRAGSTATS to calculate landscape metrics is a patch, thus, the more patches the more robust the landscape metrics. Because the largest landscape that could be sampled was 3808 ha, six portions each containing close to 600 ha of land were chosen to be placed throughout the LCTA and non-LCTA landscapes. The landscapes containing 600 ha were subsetted and FRAGSTATS was used to quantify landscape structure (Table 8). The 600-ha portions showed a better picture of what was occurring across the two landscapes, compared with the 3808 ha portion alone.

The two landscapes at this point were sampled using the nested rectangular portions along with the 600-ha equal area portions. Also, nine portions, each containing 200 ha, were placed throughout the landscapes. FRAGSTATS was then executed on the 200-ha portions (Table 9).

**Fire boundaries**

Areas of known dramatic and recent changes were needed to see if the landscape metrics can detect known change in land cover. The quickest, most dramatic changes at CW are due to wildfire. There were six fairly recent and obvious fire boundaries occurring at CW up to 1994. The large fire of 1995 could not be accounted for in the imagery available at the time this study was done. Figure 8 shows the location of fire
Table 8. Landscape metrics for each the 600 ha portions, plus the average and standard deviations.

<table>
<thead>
<tr>
<th>Landscape metrics</th>
<th>Portion 1</th>
<th>Portion 2</th>
<th>Portion 3</th>
<th>Portion 4</th>
<th>Portion 5</th>
<th>Portion 6</th>
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<th>Population St. dev.</th>
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<tr>
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<td>605</td>
<td>612</td>
<td>592</td>
<td>594</td>
<td>593</td>
<td>598</td>
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<tr>
<td>Largest patch index (%)</td>
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<td>4.72</td>
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<td>1.43</td>
<td>1.42</td>
<td>1.45</td>
<td>1.40</td>
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<td>0.67</td>
<td>0.73</td>
<td>0.78</td>
<td>0.64</td>
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<td>0.73</td>
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<td>0.09</td>
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</tr>
<tr>
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<td>591</td>
<td>604</td>
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<td>17</td>
<td>13</td>
<td>8</td>
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<tr>
<td>Patch density (#/100 ha)</td>
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<td>195</td>
<td>174</td>
<td>225</td>
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<td>1.41</td>
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<td>0.70</td>
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<td>29</td>
<td>43</td>
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</table>
Table 9. Landscape metrics derived for each of the 200 ha portions, plus the averages and their standard deviation.

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<th>Portion 1</th>
<th>Portion 2</th>
<th>Portion 3</th>
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<th>Portion 5</th>
<th>Portion 6</th>
<th>Portion 7</th>
<th>Portion 8</th>
<th>Portion 9</th>
<th>Average</th>
<th>St. dev.</th>
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</tr>
<tr>
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<td>206</td>
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</tr>
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<td>380</td>
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<td>94</td>
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<td>99</td>
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<td>0.45</td>
<td>0.54</td>
<td>0.67</td>
<td>1.01</td>
<td>1.12</td>
<td>0.84</td>
<td>0.53</td>
<td>0.46</td>
<td>0.52</td>
<td>0.68</td>
<td>0.24</td>
</tr>
<tr>
<td>Patch Size Deviation (ha)</td>
<td>1.63</td>
<td>1.63</td>
<td>2.17</td>
<td>5.23</td>
<td>4.26</td>
<td>2.49</td>
<td>2.59</td>
<td>2.01</td>
<td>2.33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Double Log Fractal Dimension</td>
<td>1.43</td>
<td>1.48</td>
<td>1.45</td>
<td>1.42</td>
<td>1.41</td>
<td>1.38</td>
<td>1.44</td>
<td>1.40</td>
<td>1.43</td>
<td>1.43</td>
<td>0.03</td>
</tr>
<tr>
<td>Simpson's Diversity Index</td>
<td>0.62</td>
<td>0.68</td>
<td>0.69</td>
<td>0.50</td>
<td>0.56</td>
<td>0.63</td>
<td>0.65</td>
<td>0.76</td>
<td>0.66</td>
<td>0.64</td>
<td>0.07</td>
</tr>
<tr>
<td>Simpson's Evenness Index</td>
<td>0.74</td>
<td>0.85</td>
<td>0.83</td>
<td>0.59</td>
<td>0.67</td>
<td>0.72</td>
<td>0.78</td>
<td>0.91</td>
<td>0.83</td>
<td>0.77</td>
<td>0.10</td>
</tr>
<tr>
<td>Interspersion Index (%)</td>
<td>60</td>
<td>58</td>
<td>56</td>
<td>35</td>
<td>37</td>
<td>44</td>
<td>57</td>
<td>80</td>
<td>74</td>
<td>56</td>
<td>15</td>
</tr>
<tr>
<td>Contagion</td>
<td>46</td>
<td>39</td>
<td>44</td>
<td>65</td>
<td>59</td>
<td>59</td>
<td>46</td>
<td>36</td>
<td>39</td>
<td>48</td>
<td>10</td>
</tr>
<tr>
<td><strong>Non-LCTA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Area (ha)</td>
<td>199</td>
<td>204</td>
<td>201</td>
<td>194</td>
<td>200</td>
<td>200</td>
<td>203</td>
<td>204</td>
<td>199</td>
<td>201</td>
<td>3</td>
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<tr>
<td>Largest Patch Index (%)</td>
<td>12</td>
<td>10</td>
<td>15</td>
<td>20</td>
<td>7</td>
<td>9</td>
<td>12</td>
<td>5</td>
<td>6</td>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td>Number of Patches</td>
<td>400</td>
<td>317</td>
<td>274</td>
<td>340</td>
<td>473</td>
<td>529</td>
<td>341</td>
<td>486</td>
<td>413</td>
<td>397</td>
<td>81</td>
</tr>
<tr>
<td>Patch Density (#/100 ha)</td>
<td>201</td>
<td>156</td>
<td>136</td>
<td>175</td>
<td>237</td>
<td>264</td>
<td>168</td>
<td>239</td>
<td>207</td>
<td>198</td>
<td>40</td>
</tr>
<tr>
<td>Mean patch size (ha)</td>
<td>0.50</td>
<td>0.64</td>
<td>0.74</td>
<td>0.57</td>
<td>0.42</td>
<td>0.38</td>
<td>0.60</td>
<td>0.42</td>
<td>0.48</td>
<td>0.53</td>
<td>0.11</td>
</tr>
<tr>
<td>Patch Size Deviation (ha)</td>
<td>2.045</td>
<td>4.863</td>
<td>2.429</td>
<td>1.09</td>
<td>1.158</td>
<td>1.771</td>
<td>0.979</td>
<td>1.186</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Double Log Fractal Dimension</td>
<td>1.46</td>
<td>1.39</td>
<td>1.44</td>
<td>1.47</td>
<td>1.42</td>
<td>1.42</td>
<td>1.45</td>
<td>1.45</td>
<td>1.44</td>
<td>1.44</td>
<td>0.02</td>
</tr>
<tr>
<td>Simpson's Diversity Index</td>
<td>0.66</td>
<td>0.52</td>
<td>0.74</td>
<td>0.73</td>
<td>0.67</td>
<td>0.71</td>
<td>0.75</td>
<td>0.79</td>
<td>0.74</td>
<td>0.70</td>
<td>0.07</td>
</tr>
<tr>
<td>Simpson's Evenness Index</td>
<td>0.79</td>
<td>0.62</td>
<td>0.86</td>
<td>0.92</td>
<td>0.80</td>
<td>0.85</td>
<td>0.94</td>
<td>0.95</td>
<td>0.92</td>
<td>0.85</td>
<td>0.1</td>
</tr>
<tr>
<td>Interspersion Index (%)</td>
<td>55</td>
<td>67</td>
<td>64</td>
<td>77</td>
<td>68</td>
<td>64</td>
<td>79</td>
<td>86</td>
<td>76</td>
<td>71</td>
<td>9</td>
</tr>
<tr>
<td>Contagion</td>
<td>42</td>
<td>53</td>
<td>41</td>
<td>28</td>
<td>40</td>
<td>38</td>
<td>26</td>
<td>23</td>
<td>29</td>
<td>36</td>
<td>9</td>
</tr>
</tbody>
</table>
Fig. 8. Location of the fire boundaries occurring at Camp Williams prior to 1995.
boundaries up to 1994. These fire boundaries were determined utilizing a Trimble GPS (Godfrey 1995) and dated by growth ring analysis of several oakbrush stems within the fire boundaries (Van Niel 1995). The fire boundaries were laid over the LCTA landscape and the non-LCTA landscape. By utilizing the AOI dialog box, polygons were drawn around each fire boundary in the LCTA and non-LCTA landscape. The areas contained within the fire boundaries were calculated for both landscapes (Table 10). These areas were then compared to determine how much burned areas were contained within the LCTA and non-LCTA landscape.

A synoptic approach

Most studies or experiments yield a set of data from a sample of some population. This is because rarely is it possible, especially affordable, to enumerate the entire population. Representative data are then compiled and statistically analyzed to infer something about that population.

This was a synoptic study, which differs from traditional investigations, in that the total population was quantified. Such a synoptic approach was made possible by the application of RS and GIS technology. Because the total population was sampled in the LCTA landscape and in most of the non-LCTA landscape, any differences that occurred between the two landscapes were differences between entire populations. Metrics shown to be numerically different represent differences in their entirety; however, it became a scientific call as to whether these differences were ecologically significant. In determining the ecological significance of differences between metrics, understanding the
Table 10. Included and excluded areas (ha) within fire boundaries A-F.

<table>
<thead>
<tr>
<th></th>
<th>A LCTA</th>
<th>A Non-LCTA</th>
<th>B LCTA</th>
<th>B Non-LCTA</th>
<th>C LCTA</th>
<th>C Non-LCTA</th>
<th>D LCTA</th>
<th>D Non-LCTA</th>
<th>E LCTA</th>
<th>E Non-LCTA</th>
<th>F LCTA</th>
<th>F Non-LCTA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oakbrush</td>
<td>2</td>
<td>12</td>
<td>2.5</td>
<td>33</td>
<td>0</td>
<td>0</td>
<td>83</td>
<td>192</td>
<td>1.6</td>
<td>0.96</td>
<td>14</td>
<td>19</td>
</tr>
<tr>
<td>Juniper</td>
<td>0</td>
<td>0</td>
<td>3.5</td>
<td>3.84</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.6</td>
<td>3.5</td>
<td>2.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Vegetated</td>
<td>2.5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Agriculture</td>
<td>0.16</td>
<td>10</td>
<td>0.84</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>63</td>
<td>130</td>
<td>0</td>
<td>0.6</td>
<td>8.8</td>
<td>27</td>
</tr>
<tr>
<td>Oak/sage-brush mix</td>
<td>0</td>
<td>4.3</td>
<td>18.0</td>
<td>41</td>
<td>0.44</td>
<td>0.36</td>
<td>32</td>
<td>82</td>
<td>4.2</td>
<td>5.4</td>
<td>4.2</td>
<td>23</td>
</tr>
<tr>
<td>Sagebrush</td>
<td>0</td>
<td>0.68</td>
<td>63.2</td>
<td>29.2</td>
<td>0.24</td>
<td>6.52</td>
<td>47</td>
<td>54</td>
<td>1.7</td>
<td>2.4</td>
<td>0.04</td>
<td>1.6</td>
</tr>
<tr>
<td>Sagebrush/ grass mix</td>
<td>0</td>
<td>1.2</td>
<td>1.5</td>
<td>0.8</td>
<td>0.56</td>
<td>23</td>
<td>24</td>
<td>0.76</td>
<td>1.4</td>
<td>0.04</td>
<td>0.04</td>
<td>0.44</td>
</tr>
<tr>
<td>Bare/annual weeds</td>
<td>0</td>
<td>0</td>
<td>0.36</td>
<td>0.32</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bare agriculture</td>
<td>0.6</td>
<td>4.8</td>
<td>8.9</td>
<td>11.9</td>
<td>0.68</td>
<td>7.4</td>
<td>247</td>
<td>483</td>
<td>12</td>
<td>13</td>
<td>28</td>
<td>72</td>
</tr>
</tbody>
</table>

Total fire area in LCTA (ha): 381
Total fire area in Non-LCTA (ha): 722
variability of these metrics was essential. In this approach, metrics were compared, yet the variability between these metrics was also compared in order to determine whether numerical differences observed represented possible ecological differences. In observing population variability, ecological significance is questionable in a situation where the variability between metrics overlaps, as such an overlap may suggest little difference to managers. On the other hand, if overlap does not occur between the metrics, this suggests that such a difference may reflect some ecological significance on the ground. More experience with these newly available means of comparison will be required before we can make confident decisions from them.
Landscape-level metrics

FRAGSTATS can calculate patch-, class-, and landscape-level metrics. This study focuses specifically on the landscape-level metrics. Patch- and class-level metrics would be especially important if the land manager were interested in managing for a particular type of habitat. With the LCTA monitoring project at CW, there were no major objectives pertaining to particular vegetation classes; therefore, class- and patch-level metrics have been ignored in this study.

Vegetation of Camp Williams

Percent vegetation was calculated for each class Van Niel (1995) classified within the CW boundary (Table 4). Oakbrush, one of the major vegetation types, occupied 22 percent of the land cover at CW. For the LCTA landscape, oakbrush comprised 20 percent and in the non-LCTA landscape, oakbrush comprised 23 percent. Juniper covered a total of six percent of CW. In the LCTA landscape, eight percent was made up of juniper, while juniper comprised five percent of the non-LCTA landscape. Fourteen percent of the total landscape in CW was made up of oak/sagebrush mix (Table 4). The LCTA landscape consisted of 11 percent of this class and 16 percent in the non-LCTA landscape. For the sagebrush type, the total CW landscape consisted of 29 percent sagebrush. The LCTA landscape had 31 percent sagebrush and the non-LCTA landscape consisted of 29 percent sagebrush. The sagebrush/grass mix comprised 21 percent of
The total area occurring within CW boundaries was 9,699 ha. The total LCTA landscape area was 3808 ha and there were 5,891 ha of land present in the non-LCTA landscape (Table 5). Due to the criteria established by the U.S. Army CERL, the LCTA monitoring program has excluded over half (61 percent) of the area of CW from monitoring. Because 61 percent of the landscape was ignored, any significant changes occurring within the larger excluded area will go undetected.

Despite the exclusion of 61 percent of the landscape from monitoring, the LCTA landscape contained all the major vegetation types (e.g., sagebrush, oakbrush) occurring on the reserve. For example, the sagebrush vegetation type represented 29 percent of
Camp William's total landscape. In the LCTA landscape, 31 percent of the cover classes were represented by sagebrush vegetation. The non-LCTA landscape was comprised of 29 percent sagebrush. All vegetation types were represented approximately equally in both the LCTA and non-LCTA areas (Table 4).

The nested portions (Table 7) show that the values of the landscape metrics were area dependent. In taking note of the nested portions (Table 7), which range from 59.5 ha to 476 ha, the landscape metrics were not as consistent as compared with the portions that contain greater areas. As the area of the landscape increases, at least for some landscape metrics (i.e., contagion and interspersion), the values appear to level. This leveling can be seen in Figures 9 and 10. Metrics, like the number of patches, increased as the landscape area increased. The landscape metrics attained from the landscapes with larger areas may be closer to the true values for the LCTA landscape and the non-LCTA landscape. Table 8 shows the landscape metrics resulting from the six 600-ha portions. Metrics from the nine portions comprising 200-ha can be viewed in Table 9.

**Largest patch index**

The largest patch index quantifies the percentage of total landscape area comprised by the largest patch (McGarigal and Marks 1995). In the 600-ha portions, the largest patch average was 10 percent in the LCTA landscape [standard deviation of the population (stdevp) is 10] and 12 percent (stdevp=8.0) in the non-LCTA landscape. In the 200-ha portions, the largest patch average comprised 17 percent (stdevp=7.0) in the
Figure 9. The relationship of the area of the landscape to landscape indices for contagion and interspersion in the non-LCTA landscape.

Figure 10. The relationship of the area of the landscape to landscape indices for contagion and interspersion in the LCTA landscape.
LCTA landscape and 14 percent (stdvp=10) in the non-LCTA landscape.

The non-LCTA landscape showed a larger average percentage for largest patch index compared with the LCTA landscape. Because the standard deviation of the populations overlapped for both the 200- and 600-ha portions, it was concluded that the largest patch index was more similar than different in both landscapes. This result was not consistent with the criteria set by the LCTA monitoring program, which established a minimum patch size, *a priori.* The expected result was that patches contained in the LCTA landscape should have been greater than the patches in the non-LCTA landscape. Hence, the LCTA landscape was not just dominated by large patches, but rather this landscape contained smaller more numerous patches than expected.

**Patch number and density**

Table 11 shows the number of patches associated with the various cover classes for the total LCTA and total non-LCTA landscapes. In the LCTA landscape, there were 894 oakbrush patches found. There were almost twice as many patches of oakbrush found on the non-LCTA landscape (1,760). The juniper cover class contained 38 percent more juniper (784) in the non-LCTA landscape than in the LCTA landscape (483). The oak/sagebrush mix had 1,289 patches in the LCTA landscape, while there were 39 percent more patches (2,109) in the non-LCTA. The sagebrush cover type consisted of 1,496 patches in the LCTA landscape and 2,103 patches in the non-LCTA landscape, or 29 percent more sagebrush patches in the non-LCTA landscape versus the LCTA landscape. In the sagebrush/grass mix, there were 809 patches in the LCTA landscape
and 1,795 patches in the non-LCTA landscape, or 55 percent more sagebrush/grass mix patches in the non-LCTA landscape versus the LCTA landscape. The patches comprising bareground and annual weeds were 453 for the LCTA landscape and 805 in the non-LCTA landscape. There were 44 percent more in the non-LCTA landscape patches than LCTA landscape patches. Bare agriculture had 115 patches in the LCTA landscape and 181 patches in the non-LCTA landscape. The LCTA landscape had two patches of vegetated agriculture whereas patches occurred in the non-LCTA landscape.

The 3,808-ha landscape portions had 5,544 patches occurring in the LCTA landscape and 6,945 patches in the non-LCTA. The patch density was 146 patches/100 ha in the LCTA landscape and 181 patches/100 ha in the non-LCTA landscape. In the 600-ha portions, the average number of patches located in the LCTA landscape was 925 (stdevp=245), while the non-LCTA landscape contained 1,078 (stdevp=162 ) patches. The average patch density was 155 patches/100 ha (stdevp=40) for the LCTA landscape.

Table 11. Number of cells and patches present in the total LCTA landscape and non-LCTA landscape.

<table>
<thead>
<tr>
<th>Vegetation class</th>
<th>LCTA landscape cells</th>
<th>Non-LCTA landscape cells</th>
<th>LCTA landscape patches</th>
<th>Non-LCTA landscape patches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oak</td>
<td>19,166</td>
<td>33,164</td>
<td>894</td>
<td>1,760</td>
</tr>
<tr>
<td>Juniper</td>
<td>7,581</td>
<td>7,016</td>
<td>483</td>
<td>784</td>
</tr>
<tr>
<td>Vegetated agriculture</td>
<td>5</td>
<td>375</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Oak sagebrush-mix</td>
<td>10,082</td>
<td>24,027</td>
<td>1,289</td>
<td>2,109</td>
</tr>
<tr>
<td>Sagebrush</td>
<td>29,349</td>
<td>41,673</td>
<td>1,496</td>
<td>2,503</td>
</tr>
<tr>
<td>Sagebrush grass-mix</td>
<td>24,928</td>
<td>26,535</td>
<td>809</td>
<td>1,795</td>
</tr>
<tr>
<td>Bare/annual weeds</td>
<td>3,228</td>
<td>7,053</td>
<td>453</td>
<td>805</td>
</tr>
<tr>
<td>Bare agriculture</td>
<td>852</td>
<td>6,528</td>
<td>115</td>
<td>181</td>
</tr>
</tbody>
</table>
and 180 patches/100 ha (stdevp=27) for the non-LCTA landscape. The 200 ha portions contained a patch number 326 (stdevp=94) in the LCTA landscape, while the non-LCTA landscape had 397 (stdevp=81) patches. The patch density was 163 patches/100 ha (stdevp=47) in the LCTA landscape and 198 patches/100 ha (stdevp=40) in the non-LCTA landscape.

There were consistently more patches present in the excluded landscape than the included landscape. This is directly reflected in the density of patches per 100 ha, which showed greater densities for the excluded areas compared with the included areas. Again, the standard deviation of the population for both landscapes overlapped in the 600-ha and 200-ha portions; as a result, it can be concluded that the landscapes were more alike than different. The fact that these landscapes were more alike than different was not consistent with the criteria set by the LCTA program. These criteria were expected to result in a LCTA landscape where patches were less numerous for a given area, while the excluded landscape was expected to consist of more numerous patches for the same area.

**Mean patch size**

The mean patch size for the 3,808-ha portions (Table 7) was 0.69 ha (stdev=4.69) in the LCTA landscape and 0.55 ha (stdev=2.51) in the non-LCTA landscape. The mean patch size for the 600-ha portions were 0.70 ha (stdev=0.21) in the LCTA landscape and 0.57 ha (stdev=0.09) in the non-LCTA landscape. The 200 ha portions had a mean patch size of 0.68 ha (stdev=0.24) in LCTA landscape and 0.53 ha (stdev=0.11) in the non-LCTA landscape.
The comparison between the nested portion of the total LCTA landscape (3,808 ha) and 3,808 ha of the non-LCTA landscape showed an unexpected result. This result was that the mean patch size was less than 1 ha in size for the LCTA landscape, which was not expected since patch sizes of greater than 2 ha in size should have occurred in the LCTA landscape. This unexpected result is shown with individual portions in the nested rectangular, 600- and 200-ha portions. For instance, in the 59.5-ha portion the mean patch size was 0.35 ha with only a patch size deviation of 0.833 ha. An explanation as to why the mean patch size in the LCTA landscape was smaller than expected is found in Chapter 5. Another unexpected result was that there existed patches greater than 2 ha in the non-LCTA landscape, which should not have been the case. The nested rectangular, 600-, and 200-ha portions in the non-LCTA landscape showed large patch size deviations greater than 2 ha. For example, for the first 600-ha portion in the non-LCTA landscape, the mean patch size was 0.72 and with a patch size deviation of 5.27 ha. This was not expected because supposedly areas greater than 2 ha in size occurred only in the LCTA landscape.

The mean patch size alone did not offer much information about the landscape, but when viewed together with patch size variability, a key aspect of landscape heterogeneity was captured. First, in viewing the variability of patch size relative to the 3,808 ha-portions, the distribution of patch sizes was skewed to the left as opposed to normally distributed for both the LCTA and non-LCTA landscapes. The patch size variability was higher in the LCTA landscape (stdev=4.69) compared with the non-LCTA landscape (stdev=2.51). In the LCTA landscape, there were smaller patches than
expected, though the LCTA landscape contained more larger patches and less smaller patches compared with the non-LCTA landscape. In the non-LCTA landscape, patch size variability was smaller. There were many smaller patches and few larger patches in the non-LCTA landscape compared with the LCTA landscape. The greater patch size variability in the LCTA landscape indicated less uniformity in pattern compared with non-LCTA landscape. Even though the LCTA landscape contained larger patches and the non-LCTA contained smaller patches, overlap did occur based on the patch size deviation; therefore, the two landscapes were more alike than different.

Possibly the mean patch size for the non-LCTA landscape would have been smaller; however, an anomaly exists in the western portion of the non-LCTA landscape, where patches greater than 2 ha in size were found to occur, based on both Van Nieil’s map and CERL’s data base. This can be seen in the left-hand side of Figure 6. Patches of this size should have only been found in the LCTA landscape. This area, consisting of larger homogenous patches, biased the results of the mean patch size analysis, resulting in larger mean patch sizes for the excluded area, and a smaller patch density. However, in the 600-ha portions for the non-LCTA landscape, the mean patch size for several of the 600-ha portions showed a greater than expected mean patch size. This suggests that despite the anomalous area, there were still patch sizes greater than 2 ha occurring in the non-LCTA landscape.

**Double log fractal dimension**

The fractal dimension is an index that quantifies the complexity of shapes
occurring on the landscape (O'Neil et al. 1988). A landscape composed of simple geometric shapes, like squares and rectangles, will have a small fractal dimension. The fractal dimension will be large in a landscape that contains many patches with complex and convoluted shapes (Krummel et al. 1987). The greater the double log fractal dimension, the greater the patch shape complexity.

In the nested portions, the double log fractal dimension was 1.43 in the included landscape and 1.45 in the excluded landscape. In the 600-ha portions, the LCTA landscape showed an average double log fractal dimension of 1.43 (stdevp=0.02) and the non-LCTA was 1.44 (stdevp=0.02). In the 200-ha portions, the LCTA landscape had a double log fractal dimension of 1.43 (stdevp=0.03) and the non-LCTA landscape had an average value of 1.44 (stdevp=0.02).

The double log fractal dimensions were marginally greater for excluded than included areas, though, because the standard deviations of the population overlapped, the two landscapes were more alike than different.

**Simpson's diversity index and Simpson's evenness index**

In the 3,808 ha nested portions, the LCTA landscape had a Simpson's diversity index value of 0.78, whereas the non-LCTA had a value of 0.80. The LCTA landscape in 600-ha portions had an average value of 0.67 (stdevp=0.07), while the non-LCTA landscape had a value of 0.71 (stdevp=0.03). In the 200-ha portions, the LCTA landscape had a value of 0.64 (stdevp=0.07) and the non-LCTA landscape had a value of 0.70 (stdevp=0.07).
The value of Simpson's index represents the probability that any two cover types selected at random would be different. A value of 0.79 means that there is a 79 percent probability that two randomly chosen patches would represent different patch types. Thus, the higher the diversity value, the greater the likelihood that any two randomly drawn patches would be different patch types (i.e., greater diversity) (McGarigal and Marks 1995). The excluded landscape showed a greater value for the Simpson's diversity index in the nested rectangular, 200-, and 600-ha portions, compared with the included landscape, though, again because the variability resulted in an overlap between the two landscapes, it was concluded that the LCTA and non-LCTA landscapes were more alike than different.

The evenness measure shows how equally distributed the patches are in the landscape. The Simpson's evenness index in the 3,808-ha nested portions was 0.86 in the LCTA landscape and 0.93 in the non-LCTA landscape. The 600-ha portions showed a value of 0.80 (stdevp=0.09) in the included landscape and 0.85 (stdevp=0.04 ) in the excluded landscape. The 200-ha portions in the LCTA landscape was 0.77 (stdevp=0.09) and 0.85 (stdevp=0.10 ) in the non-LCTA landscape.

Evenness measures the distribution of area among patch types (McGarigal and Marks 1995). Larger evenness values indicate greater landscape evenness. A Simpson's evenness index of 80 percent can be interpreted as the distribution of area among patch type is 80 percent of the maximum evenness for a given landscape. The non-LCTA landscape had greater evenness values compared with the LCTA landscape, though, the
standard deviation of the population overlapped, showing that the two landscapes were more alike than different.

The diversity metrics computed by FRAGSTATS were influenced by two components, richness and evenness (Maggurran 1988). Richness refers to the number of patches present and evenness refers to the distribution of area among different types. Because these indices take both evenness and species richness into account, they are termed heterogeneity indices (Maggurran 1988). Richness values for both landscapes were the same since they contained the same cover types; therefore, the evenness and diversity indices were not biased by richness. It is important to note that evenness and richness do not convey any information about which patch types are most or least abundant or which may be of greater ecological significance (McGarigal and Marks 1995).

**Interspersion and contagion**

The interspersion index measures the extent to which patch types are interspersed. The interspersion value for the included landscape in the nested portions was 52 percent and 73 percent in the non-LCTA landscape. The 600-ha portions showed an average value of 63 percent (stdevp=12) in the LCTA landscape and 72 percent (stdevp=5.0) in the non-LCTA landscape. The value for interspersion in the 200-ha portions was 56 percent (stdevp=14) in the LCTA landscape and 71 percent (stdevp=9.0) in the non-LCTA landscape.
Consistently, the values for interspersion were greater for the excluded landscape than the included landscape. The 200-ha portion showed no overlap between the two landscapes, while the 600 ha portions showed overlap. Interspersion for the 600-ha portions were more alike than different, whereas interspersion for the 200-ha portions show a small difference as demonstrated by the standard deviation of the population. Higher interspersion values result from a landscape in which the patch types are well interspersed, representing greater diversity, whereas lower values characterize landscapes in which the patch types are poorly interspersed (McGarigal and Marks 1995).

Contagion measures the intermixing of units of different patch types. A landscape in which the patch types are well interspersed will have a lower contagion value compared with a landscape in which patch types are poorly interspersed. Therefore, contagion measures the extent to which patch types are aggregated or clumped (i.e., dispersion) (O'Neill et al. 1988). In the 3,808 nested portions, mean contagion was 52 for the LCTA landscape and 33 for the non-LCTA landscape. The 600-ha portions had a mean value of 46 (stdevp=8) in the LCTA landscape and 36 (stdevp=4) in the non-LCTA landscape. The 200-ha portions had an average contagion value of 48 (stdevp=10) in the LCTA landscape and 36 (stdevp=9) in the non-LCTA landscape. Higher mean values of contagion may result from landscapes with a few large, contiguous patches, whereas lower mean values generally characterize landscape with many small and dispersed patches (O'Neill et al. 1988).

The mean contagion values were different in the included landscape compared with the excluded landscape. The standard deviation of the population between the two
lands ca ps did not o ver lap; thus, a small difference suggests that the LCTA landscape contained fewer, larger, and more contiguous patches, relative to the excluded landscape. This reinforces the discussion above in that the LCTA landscape contained fewer smaller patches compared with the non-LCTA landscape.

**Area within the fire boundaries**

The fire boundaries for both the LCTA and non-LCTA landscape were determined (Table 10). The A fire boundary included within the LCTA landscape comprised 4.6 ha, while the non-LCTA landscape contained 29 ha. The B fire boundary in the included landscape had 90 ha, while the excluded landscape comprised 119 ha. The included landscape in the C fire boundary had 0.68 ha and the excluded landscape contained 7.4 ha. The D fire boundary had 247 ha of land in the included LCTA landscape and 483 ha in the excluded landscape. The E fire boundary in the LCTA landscape comprised 12 ha and 13 ha in the non-LCTA landscape. The F fire boundary contained 28 ha in the LCTA landscape, while the non-LCTA fire boundary was 72. The total amount of area occurring within the LCTA fire boundaries was 381 ha, and 722 ha within the non-LCTA fire boundaries.

There were clearly more burned areas located in the non-LCTA landscape compared with the LCTA landscape. This information is important, as these areas may be important to the land manager.

**Advantages and disadvantages of a synoptic study**

This is a synoptic study of an entire landscape as opposed to the study of random
subsamples from that landscape; as a result, conventional statistical testing was not appropriate. In time, however, the metrics generated here may be statistically tested via time series to detect changes in metric values over time for this landscape.

The most important outcome of this study was that the two landscapes were more alike than different, which was not expected due to the criteria set by the LCTA monitoring program. In this study, the population variance was utilized in order to compare those metrics that had calculated means. Because the total population in the LCTA landscape was sampled and a majority of the non-LCTA landscape was also sampled, the mean values for the entire populations were known. Thus, an advantage of a synoptic study is that whole populations are sampled and there is no need for subsampling. With conventional statistics, subsamples are needed to infer something about the population.
CHAPTER 5

IMPLICATIONS AND CONCLUSION

Introduction

Due to the criteria set by the LCTA program, it was expected that the patches comprising the LCTA landscape would be larger, less numerous, and less diverse than those of the excluded landscape. The expectations were not reached, as the two landscapes were more alike than different for the majority of the metrics used. The interspersion metric for the 200-ha portion and the contagion metric for both the 200/600-ha portions did show a small difference between the two landscapes; however, this result is the only one that reached expectations. Along with the conclusion that the two landscapes were more alike than different, other outcomes resulting from the LCTA monitoring program were observed. The following discusses the implications arising from the LCTA monitoring approach.

The significance of this landscape approach to the land manager

Most of the landscape-level indices explored in this analysis show that the two landscapes were more alike than different. This result was not expected due to the criteria set by the LCTA monitoring program to locate monitoring sites. The non-LCTA landscape was explicitly excluded from the LCTA monitoring protocol because it appeared to be more complex, thus making these areas more challenging to monitor. The population variance showed that although numerical differences did occur between the two landscapes, the two landscapes were more alike than different. Since it has been
shown for the majority of landscape metrics that the two landscapes were more alike than different, the 5,891 ha of excluded land should have also been considered in the random stratification process that was utilized to locate inventory sites.

The population variance for the interspersion at 200 ha and contagion at 600/200 ha did not overlap. It is important to emphasize that the functional significance of these differences in contagion and interspersion is unknown so far. Little is understood about these landscape metrics and what they mean on the ground. Turner (1989) stated that landscapes have critical thresholds at which ecological processes will change qualitatively. These thresholds are largely unknown and how such thresholds correspond to particular landscape indices needs further study. In the context of this study, it is a scientific call as to whether these small differences observed are biologically significant on the ground. Most metrics demonstrated that the two landscapes were more alike than different, and thus it can be argued that the differences were not biologically significant.

In this study, the diversity metrics appeared less useful to the land manager than the others available. The more useful metrics were patch size, density, and numbers because they showed a better picture of what was occurring across the two landscapes. Even though there was overlap with patch size variability, it was shown that the non-LCTA landscape contained many more, smaller patches compared with the LCTA landscape. These smaller patches cannot be overlooked, because this characteristic suggests that pockets of heterogeneity exist within the non-LCTA landscape that have gone unmonitored and such knowledge may be important to the land manager.
Problems arising from the unsupervised classification

The LCTA monitoring program utilizes remote sensing technology in order to allocate monitoring points. The program attempts to substitute computer-based analysis for vital ground work in locating monitoring sites. It is important to understand the ramifications of such an approach.

An unsupervised classification was used to identify spectral clusters. Monitoring sites were selected by the stratification of these spectral categories with soil mapping units (Warren and Bagley 1992). The stratification was applied to ensure that all spectral categories were represented (Warren and Bagley 1992). The number of sites assigned to an individual spectral category and soil mapping unit combinations was proportional to the percent of the total land area that it covered (Warren and Bagley 1992). In other words, if 20 percent of the landscape was represented by a particular spectral category and soil mapping unit combination, then 20 percent of the monitoring sites were placed in these areas.

As described above, these spectral clusters were never ground truthed, and a particular spectral cluster does not always correspond to a single cover type. Rather, one spectral class may represent more than one cover type. For example, the sagebrush cover type corresponds to the same spectral category as the juniper cover type. Table 12 shows the predominant vegetation types comprising particular spectral categories. Image category number one shows several associated cover classes within each category.
Table 12. Vegetation classes associated with each monitoring number and LCTA image category associated with the monitoring site. These data were acquired from the LCTA monitoring program at CW.

<table>
<thead>
<tr>
<th>Plot number</th>
<th>LCTA image category number</th>
<th>Vegetation type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Sagebrush/shrub</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>Sagebrush/shrub</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>Juniper/shrub</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>Sagebrush</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>Juniper</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>Juniper/shrub</td>
</tr>
<tr>
<td>85</td>
<td>1</td>
<td>Sagebrush/annual</td>
</tr>
<tr>
<td>86</td>
<td>1</td>
<td>Juniper/shrub</td>
</tr>
<tr>
<td>88</td>
<td>1</td>
<td>Sagebrush/shrub</td>
</tr>
<tr>
<td>90</td>
<td>1</td>
<td>Annual</td>
</tr>
<tr>
<td>7</td>
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<td>2</td>
<td>Annual</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>Juniper/shrub</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
<td>Juniper/shrub</td>
</tr>
<tr>
<td>11</td>
<td>2</td>
<td>Rabbitbrush</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
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<td>13</td>
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</tr>
<tr>
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<td>2</td>
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<td>83</td>
<td>2</td>
<td>Sagebrush/grass</td>
</tr>
<tr>
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<td>Sagebrush/shrub</td>
</tr>
<tr>
<td>30</td>
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<td>Juniper/shrub</td>
</tr>
<tr>
<td>31</td>
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<tr>
<td>32</td>
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</tr>
<tr>
<td>15</td>
<td>3</td>
<td>Juniper/shrub</td>
</tr>
<tr>
<td>16</td>
<td>3</td>
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</tr>
<tr>
<td>17</td>
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</tr>
<tr>
<td>77</td>
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</tr>
<tr>
<td>79</td>
<td>3</td>
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**Table 12. Continued.**

<table>
<thead>
<tr>
<th>Plot number</th>
<th>LCTA image category number</th>
<th>Vegetation type</th>
</tr>
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<tbody>
<tr>
<td>19</td>
<td>4</td>
<td>Oak</td>
</tr>
<tr>
<td>20</td>
<td>4</td>
<td>Oak</td>
</tr>
<tr>
<td>21</td>
<td>4</td>
<td>Oak</td>
</tr>
<tr>
<td>22</td>
<td>4</td>
<td>Oak</td>
</tr>
<tr>
<td>23</td>
<td>4</td>
<td>Oak/shrub</td>
</tr>
<tr>
<td>24</td>
<td>4</td>
<td>Oak</td>
</tr>
<tr>
<td>70</td>
<td>4</td>
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<td>71</td>
<td>4</td>
<td>Oak</td>
</tr>
<tr>
<td>72</td>
<td>4</td>
<td>Oak/shrub</td>
</tr>
<tr>
<td>73</td>
<td>4</td>
<td>Oak</td>
</tr>
<tr>
<td>25</td>
<td>5</td>
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<tr>
<td>26</td>
<td>5</td>
<td>Sage annuals</td>
</tr>
<tr>
<td>27</td>
<td>5</td>
<td>Annual grass</td>
</tr>
<tr>
<td>28</td>
<td>5</td>
<td>Annual grass</td>
</tr>
<tr>
<td>29</td>
<td>5</td>
<td>Sage grass</td>
</tr>
<tr>
<td>31</td>
<td>5</td>
<td>Sage annuals</td>
</tr>
<tr>
<td>32</td>
<td>5</td>
<td>Sage annuals</td>
</tr>
<tr>
<td>33</td>
<td>5</td>
<td>Annual grass</td>
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<tr>
<td>68</td>
<td>5</td>
<td>Annual grass</td>
</tr>
<tr>
<td>69</td>
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<td>Annual</td>
</tr>
<tr>
<td>34</td>
<td>6</td>
<td>Sage grass</td>
</tr>
<tr>
<td>36</td>
<td>6</td>
<td>Annual grass</td>
</tr>
<tr>
<td>37</td>
<td>6</td>
<td>Annual</td>
</tr>
<tr>
<td>39</td>
<td>6</td>
<td>Annual</td>
</tr>
<tr>
<td>64</td>
<td>6</td>
<td>Annual grass</td>
</tr>
<tr>
<td>65</td>
<td>6</td>
<td>Perennial grass</td>
</tr>
<tr>
<td>66</td>
<td>6</td>
<td>Sagebrush/grass</td>
</tr>
<tr>
<td>67</td>
<td>6</td>
<td>Sagebrush/grass</td>
</tr>
</tbody>
</table>
Table 12. Continued.

<table>
<thead>
<tr>
<th>Plot number</th>
<th>LCTA image category number</th>
<th>Vegetation type</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>7</td>
<td>Oakbrush (open)</td>
</tr>
<tr>
<td>41</td>
<td>7</td>
<td>Oakbrush (open)</td>
</tr>
<tr>
<td>42</td>
<td>7</td>
<td>Oakbrush/shrub</td>
</tr>
<tr>
<td>43</td>
<td>7</td>
<td>Oakbrush/shrub</td>
</tr>
<tr>
<td>60</td>
<td>7</td>
<td>Oakbrush (open)</td>
</tr>
<tr>
<td>62</td>
<td>7</td>
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<td>63</td>
<td>7</td>
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<tr>
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<td>45</td>
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<tr>
<td>58</td>
<td>8</td>
<td>Oakbrush</td>
</tr>
<tr>
<td>47</td>
<td>9</td>
<td>Oakbrush/shrub</td>
</tr>
<tr>
<td>48</td>
<td>9</td>
<td>Oakbrush (open)</td>
</tr>
<tr>
<td>49</td>
<td>9</td>
<td>Sagebrush/shrub</td>
</tr>
<tr>
<td>50</td>
<td>9</td>
<td>Oakbrush (open)</td>
</tr>
<tr>
<td>51</td>
<td>9</td>
<td>Oakbrush (open)</td>
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<tr>
<td>52</td>
<td>9</td>
<td>Oakbrush/shrub</td>
</tr>
<tr>
<td>54</td>
<td>9</td>
<td>Sagebrush/shrub</td>
</tr>
</tbody>
</table>

Some cover classes (e.g., oakbrush and annuals) were represented by a single image category. Oakbrush areas were in most cases dominated by a robust cover with little interspace for other plant species to persist. This can be seen with image category number four in Table 12. Furthermore, annuals thrive in degraded areas where there is much soil exposure. Like oakbrush, these areas have a distinct spectral signature. This can be seen with image category number five in Table 12. On the other hand, sagebrush, sagebrush/shrub, oakbrush/shrub, and sagebrush/grass areas were not easily differentiated by spectral signature. This results in more than one cover class represented by a single
image category, and this is reflected in Table 12. These problems could be amended with ground truthing.

The land manager must understand the ramifications from the selection of non-ground truthed monitoring sites derived from an unsupervised classification. Such a system of classification could pose problems in the stratification of statistical spectral cluster and soil mapping unit combinations, as a particular cover type may not be adequately sampled. Warren and Bagley (1992, p.36) stated, “It is important that sampled portions are representative of the kinds and conditions of land resources actually existing on the monitored landscape.” It is also important to understand that in this case, representative sample sites were not chosen on the basis of community type or condition of land resources; rather, representativeness was based on statistical spectral clusters, where one spectral cluster type represented several community types. As it pertains to the application of this approach to CW, Table 4 shows that each cover type was sampled in proportion to its distribution in the landscape and this is a strength of this approach as applied to CW.

Scale and homogeneity

A question that arose in the field and during computer analysis pertained to the issue of homogeneity. It is agreed that homogeneity is scale dependent or a hierarchical mosaic of patches within patches occurs over a broad range of scales (Kotliar and Wiens 1990; Senft et al. 1987). The LCTA program is concerned with monitoring community-level change. LCTA monitoring sites were located by utilizing remotely sensed imagery
to identify homogenous patches at the landscape level and patches thus identified were considered for monitoring. The LCTA monitoring program is attempting to monitor community-level change in patches that were identified as homogeneous at the landscape level, though in many of the areas, homogeneity identified at the landscape-level was not present at the community-level.

This change in homogeneity with change of scale was experienced first hand in the field. When viewed on the ground, LCTA monitoring sites were not commonly found to be homogenous areas, but areas that contained several vegetation classes. In many cases, it appeared that the monitoring transect merged into ecotones. This was a function of how the sites were selected from the imagery. The LCTA monitoring program defined homogeneity at the landscape scale, yet monitored at the community scale, and at this scale, some areas were no longer homogenous. Due to the homogeneity problem and the lack of ground truthing, many LCTA spectral clusters were dissected by more patches than represented by the final map used to identify monitoring sites. As a result, the LCTA program is serendipitously monitoring a more heterogeneous landscape than planned.

This change from a more heterogeneous environment at the community scale was apparent by looking at patch sizes in the included landscape. These patch sizes were not much larger than those of the excluded landscape, despite the a priori 2-ha minimum size criteria set by the LCTA program. In fact, the average patch size in the LCTA landscape was no greater than 1 ha. The reason is that spectral categories greater than 2-ha in size were included for monitoring, though, as previously discussed, several more patches exist
within a spectral category. These patches were on the average no greater than a hectare. Had the spectral cover classes actually represented homogenous areas at the community level, greater differences between the LCTA landscape metrics and the non-LCTA landscape metrics would have occurred. This is the main explanation as to why the LCTA patches were smaller than expected and why the two landscapes were more alike than different.

**Critical areas ignored**

The LCTA program attempted to exclude soil mapping units and spectral cluster combinations of less than 2 ha in size in order to exclude patches that were small and thereby difficult to sample in the field. Unfortunately, this approach resulted in the exclusion of some important areas.

An example of this is the exclusion from monitoring of the major riparian areas at CW, which were Tickville Spring and the Jordan River banks. Since these areas did not meet the minimum size criterion, they were totally excluded from monitoring. Some fire-disturbed areas were also left out of the monitoring scheme because the recovery status of fire areas created spectral noise that was difficult to classify. It is important that the land manager pay attention to critical areas, like riparian vegetation and small burned areas, that may be overlooked with this approach.

**Monitoring objectives**

As described above, some problems have resulted due to the LCTA approach. First, this technique is automated and consistently applied to each military reserve. The
monitoring objectives are also uniform throughout, which may pose some problems in the long term. Monitoring methodology should be linked to management objectives (West et al. 1994). The LCTA program monitoring objectives are generally vague and the same for each reserve. This may lead to problems, as local objectives for management may vary. The national monitoring objectives are defined, yet local land management decisions may undermine this national monitoring approach. For monitoring to be effective, the local land manager must adjust the monitoring approach to address local management objectives. Such a flexible approach will help minimize futility in monitoring efforts over the long term.

**Incorporating a landscape measurement**

As elaborated above, the incorporation of landscape metrics into the LCTA monitoring program has shown some ramifications of the LCTA monitoring approach. By understanding such outcomes of the LCTA approach and incorporating landscape metrics into its monitoring protocol, the LCTA program could be enhanced. As shown in the CW case study, these metrics identified important patterns at the landscape scale that were not apparent at the community scale, the only scale at which the LCTA program is currently monitoring. Also, by monitoring with landscape metrics, the land manager may detect important landscape-level changes over time and thereby recognize the need to adjust management in response to these changes.

These landscape metrics can be incorporated into the LCTA monitoring program in the following ways. For example, any changes in landscape-level heterogeneity could
be detected by monitoring the change in patch numbers over time. The LCTA monitoring program may be concerned with managing a particular habitat type. For example, sagebrush/oakbrush mix may be a suitable habitat for a particular animal. These areas can be spatially displayed at a landscape scale, and numerous landscape metrics like the number of patches or area represented by this habitat type can be quantified. Over time, the patch characteristics of this habitat type can be monitored to detect any important changes. The U.S. Army may also be concerned with a particular patch type because of its fire potential. Over time, these areas can be monitored at the landscape level in order to assess whether these areas are increasing or decreasing. Lastly, the community-level information collected over time can be compared to landscape-level pattern changes in order to understand the association between community level changes and changes in landscape pattern.

Conclusion

In recent years, a larger scale view of ecological phenomena is possible because of GIS and RS technology. The natural resource field is rapidly applying this recent technology to many studies. Much has been written on how this technology has been applied, yet little is written on the outcomes that may arise from the use of such tools. This analysis described some ramifications that resulted from the use of these tools by the LCTA monitoring program.

In this case study, landscape metrics were incorporated into the LCTA monitoring program, and by quantifying landscape structure, some outcomes associated with the
LCTA monitoring approach were identified. The understanding of such ramifications can strengthen the LCTA monitoring program. First, based on the criteria set by the LCTA monitoring program, it was expected that LCTA landscape would consist of larger, less numerous patches and the non-LCTA landscape would consist of smaller, more numerous patches. Contrary to what was expected, this was not the case, as the LCTA landscape contained smaller patches than expected, while the non-LCTA landscape contained larger patches than expected and the metrics showed that the two landscapes were more alike than different. This being the case, the 5,891 ha of excluded land should have been considered in the random stratification process that was utilized to locate inventory sites. It was shown in this study that the LCTA and non-LCTA landscapes appeared different to the U.S. Army CERL because the spectral clusters were never ground truthed. Also, this study showed that the excluded landscape contained critical habitat like riparian areas and many burned areas. Lastly, this study pointed out that the LCTA monitoring objectives are too generalized. This may pose some future problems because the vague LCTA monitoring objectives may make it more difficult to solve land issues compared with a monitoring program that is designed to answer more specific needs and questions.

In this study, the diversity metrics appeared less useful compared with the mean patch size, patch number, and density. Average patch size alone did not offer adequate information. In addition, patch size variability showed much about what was occurring across the two landscapes; thus, in the context of this study it was a very useful metric for the land manager. Both landscapes showed much patch size variability and because of
this variability, ground knowledge of the area is paramount in the interpretation and application of these metrics. In other words, because quantifying landscape structure results in a single number for a particular landscape index, these numbers may simplify the complexity occurring across the landscape; thus, these landscape metrics cannot totally replace ground-level knowledge. Den Boer (1981, p.52) wrote the following about heterogeneity and variability:

Heterogeneity and variability should not be considered just drawbacks of field situations, that can best be circumvented by retreating into the laboratory....On the contrary, heterogeneity and changeability must be recognized as fundamental features, not only of the natural environment of a population but also of life itself.

This study incorporated landscape metrics into the LCTA monitoring program, showing that such metrics can be applied to this type of situation and that these metrics identified important patterns at the landscape scale that were not apparent at the community scale. These metrics offered a view of the CW landscape that was not apparent at the community level. This landscape-level view can enhance the LCTA monitoring program. As well, the application of landscape metrics into future natural resource management projects looks promising.


Subset:

Processing image: subset: gis
Number of rows, cols: 210, 154
Interior Background Value: 0
Exterior Background Value: 0
Reading 8 bit ERDAS image ....

... 27530 cells of background exterior to the landscape found

<table>
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<th>Class</th>
<th>1:</th>
<th>2297 cells,</th>
<th>81 patches</th>
</tr>
</thead>
<tbody>
<tr>
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<td>2:</td>
<td>642 cells,</td>
<td>80 patches</td>
</tr>
<tr>
<td>Class</td>
<td>3:</td>
<td>722 cells,</td>
<td>110 patches</td>
</tr>
<tr>
<td>Class</td>
<td>4:</td>
<td>1086 cells,</td>
<td>85 patches</td>
</tr>
<tr>
<td>Class</td>
<td>5:</td>
<td>71 cells,</td>
<td>7 patches</td>
</tr>
<tr>
<td>Class</td>
<td>6:</td>
<td>10 cells,</td>
<td>6 patches</td>
</tr>
<tr>
<td>Class</td>
<td>7:</td>
<td>6 cells,</td>
<td>1 patches</td>
</tr>
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</table>

Number of classes: 7
Max patches/class: 110
Max patch size: 2297 (background/border patch)

<table>
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<tr>
<th>LANDSCAPE INDICES</th>
<th></th>
</tr>
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<tbody>
<tr>
<td>Total Area (ha):</td>
<td>192.400</td>
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<tr>
<td>Largest Patch Index (1):</td>
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</tr>
<tr>
<td>Number of patches:</td>
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</tr>
<tr>
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</tr>
<tr>
<td>Mean Patch Size (ha):</td>
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</tr>
<tr>
<td>Patch Size Standard Dev (ha):</td>
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<tr>
<td>Patch Size Coeff of Variation (%):</td>
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<tr>
<td>Total Edge (m):</td>
<td>92980.000</td>
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<tr>
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</tr>
<tr>
<td>Total Edge Contrast Index (%):</td>
<td>NA</td>
</tr>
<tr>
<td>Mean Edge Contrast Index (%):</td>
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</tr>
<tr>
<td>Area-Weighted Mean Edge Contrast (%):</td>
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</tr>
<tr>
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</tr>
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<td>Mean Shape Index:</td>
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<tr>
<td>Area-Weighted Mean Shape Index:</td>
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</tr>
<tr>
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<tr>
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<tr>
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<tr>
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<td>Core Area Density (1/100 ha):</td>
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<tr>
<td>Mean Core Area 1 (ha):</td>
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<tr>
<td>Core Area Standard Dev 1 (ha):</td>
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<tr>
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<tr>
<td>Shannon’s Diversity Index:</td>
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</tr>
<tr>
<td>Simpson’s Diversity Index:</td>
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<td>Shannon’s Evenness Index:</td>
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<tr>
<td>Simpson’s Evenness Index:</td>
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<tr>
<td>Modified Simpson’s Evenness Index:</td>
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<tr>
<td>Interpersion/Disjiontion Index (1):</td>
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<td>Contagion (1):</td>
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</table>
### Subset 2

Processing Image: subset2.gis
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Exterior Background Value: 0
Reading 8 bit ERDAS image ....

... 209465 cells of background exterior to the landscape found

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<th>cells</th>
<th>patches</th>
</tr>
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<td>97</td>
</tr>
<tr>
<td>2</td>
<td>647</td>
<td>111</td>
</tr>
<tr>
<td>3</td>
<td>1847</td>
<td>133</td>
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<td>4</td>
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<td>94</td>
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<td>5</td>
<td>839</td>
<td>55</td>
</tr>
<tr>
<td>6</td>
<td>17</td>
<td>7</td>
</tr>
</tbody>
</table>

Number of classes: 6  
max patches/class: 123  
max_patch_size: 14510 (background/border patch)

<table>
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<tr>
<th>LANDSCAPE INDICES</th>
<th>Value</th>
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<tr>
<td>Total Area (ha)</td>
<td>455.000</td>
</tr>
<tr>
<td>Largest Patch Index (%)</td>
<td>42.488</td>
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<td>Number of patches</td>
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<tr>
<td>Patch Size Standard Dev (ha):</td>
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<tr>
<td>Patch Size Coeff of Variation (%)</td>
<td>480.992</td>
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<td>Total Edge (m):</td>
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<tr>
<td>Edge Density (m/ha):</td>
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<tr>
<td>Contrast-Weight Edge Density (m/ha):</td>
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<tr>
<td>Total Edge Contrast Index ():</td>
<td>NA</td>
</tr>
<tr>
<td>Mean Edge Contrast Index ():</td>
<td>NA</td>
</tr>
<tr>
<td>Area-Weighted Mean Edge Contrast ():</td>
<td>NA</td>
</tr>
<tr>
<td>Landscape Shape Index:</td>
<td>18.185</td>
</tr>
<tr>
<td>Mean Shape Index:</td>
<td>1.273</td>
</tr>
<tr>
<td>Area-Weighted Mean Shape Index:</td>
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<tr>
<td>Double Log Fractal Dimension:</td>
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<tr>
<td>Mean Patch Fractal Dimension:</td>
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<tr>
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<tr>
<td>Core Area Coeff of Variation 2 (%):</td>
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<tr>
<td>Total Core Area Index ():</td>
<td>12.405</td>
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<tr>
<td>Mean Core Area Index ():</td>
<td>3.157</td>
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<tr>
<td>Mean Nearest Neighbor (m):</td>
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<tr>
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<td>Mean Proximity Index:</td>
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<tr>
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<td>Relative Patch Richness ():</td>
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<tr>
<td>Shannon's Evenness Index:</td>
<td>0.622</td>
</tr>
<tr>
<td>Simpson's Evenness Index:</td>
<td>0.655</td>
</tr>
<tr>
<td>Modified Simpson's Evenness Index:</td>
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<tr>
<td>Interdispersion/Interspacing Index (%):</td>
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<td>Contagion ():</td>
<td>49.559</td>
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</table>
... 21318 cells of background exterior to the landscape found

<table>
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<th>Patches</th>
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<td>1111</td>
<td>119</td>
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<tr>
<td>3</td>
<td>1864</td>
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<td>513</td>
<td>51</td>
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<tr>
<td>6</td>
<td>123</td>
<td>39</td>
</tr>
</tbody>
</table>

number of classes: 6
max patches/class: 246
max_patch_size: 19535 (background/border patch)

LANDSCAPE INDICES

- Total Area (ha): 440.880
- Largest Patch Index (1): 14.235
- Number of patches: 820
- Patch Density (#/100 ha): 185.992
- Mean Patch Size (ha): 0.538
- Patch Size Standard Dev (ha): 2.814
- Patch Size Coeff of Variation (%): 523.297
- Total Edge (m): 2012000
- Edge Density (m/ha): 456.632
- Contrast-Weight Edge Density (m/ha): NA
- Total Edge Contrast Index (3): NA
- Mean Edge Contrast Index (3): NA
- Area-Weighted Mean Edge Contrast (2): NA
- Landscape Shape Index: 23.470
- Mean Shape Index: 1.274
- Area-Weighted Mean Shape Index: 3.037
- Double Log Fractal Dimension: 1.430
- Mean Patch Fractal Dimension: 1.045
- Area-Weighted Mean Fractal Dimension: 1.173
- Total Core Area (ha): 135.320
- Number of Core Areas: 225
- Core Area Density (#/100 ha): 51.034
- Mean Core Area 1 (ha): 0.163
- Core Area Standard Dev 1 (ha): 1.543
- Core Area Coeff of Variation 1 (%): 93.150
- Mean Core Area 2 (ha): 0.601
- Core Area Standard Dev 2 (ha): 2.901
- Core Area Coeff of Variation 2 (%): 1758.042
- Total Core Area Index (%): 30.693
- Mean Core Area Index (%): 2.637
- Mean Nearest Neighbor (a): 57.240
- Nearest Neighbor Standard Dev (a): 76.370
- Nearest Neigh Coeff of Variation (%): 123.422
- Mean Proximity Index: NA
- Shannon's Diversity Index: 1.421
- Simpson's Diversity Index: 0.709
- Modified Simpson's Diversity Index: 1.233
- Patch Richness: 6
- Patch Richness Density (#/100 ha): 1.361
- Relative Patch Richness (%): NA
- Shannon's Evenness Index: 0.793
- Simpson's Evenness Index: 0.850
- Modified Simpson's Evenness Index: 0.680
- Interspersion/Interspersion Index (%): 73.331
- Contagion (%): 40.253
... 22256 cells of background exterior to the landscape found

<table>
<thead>
<tr>
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<th>Patches</th>
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<td>20</td>
<td>2</td>
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<tr>
<td>4</td>
<td>1889</td>
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<td>6</td>
<td>828</td>
<td>54</td>
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<tr>
<td>9</td>
<td>105</td>
<td>35</td>
</tr>
</tbody>
</table>

- Number of classes: 6
- Max patches/class: 305
- Max_patch_size: 21416 (background/border patch)

**Landscape Indices**

- Total Area (ha): 403.360
- Largest Patch Index (%): 11.831
- Number of patches: 704
- Patch Density (#/100 ha): 174.534
- Mean Patch Size (ha): 0.573
- Patch Size Standard Dev (ha): 2.868
- Patch Size Coeff of Variation (%): 50.521
- Total Edge (m): 19576.000
- Edge Density (m/ha): 485.323
- Contrast-Weight Edge Density (m/ha): NA
- Total Edge Contrast Index (%): NA
- Mean Edge Contrast Index (%): NA
- Area-Weighted Mean Edge Contrast (%): NA
- Landscape Shape Index: 24.368
- Mean Shape Index: 1.103
- Area-Weighted Mean Shape Index: 3.313
- Double log Fractal Dimension: 1.644
- Mean Patch Fractal Dimension: 1.048
- Area-Weighted Mean Fractal Dimension: 1.184
- Total Core Area (ha): 116.440
- Number of Core Areas: 300
- Core Area Density (#/100 ha): 49.582
- Mean Core Area 1 (ha): 0.165
- Core Area Standard Dev 1 (ha): 1.458
- Core Area Coeff of Variation 1 (%): 88.490
- Mean Core Area 2 (ha): 0.502
- Core Area Standard Dev 2 (ha): 2.691
- Core Area Coeff of Variation 2 (%): 1626.783
- Total Core Area Index (%): 28.806
- Mean Core Area Index (%): 2.757
- Mean Nearest Neighbor (m): 60.405
- Nearest Neighbor Standard Dev (m): 84.800
- Nearest Neighbor Coeff of Variation (%): 139.934
- Mean Proximity Index: NA
- Shannon's Diversity Index: 1.113
- Simpson's Diversity Index: 0.573
- Modified Simpson's Diversity Index: 0.650
- Patch Richness: 6
- Patch Richness Density (#/100 ha): 1.488
- Relative Patch Richness (%): 3.604
- Shannon's Evenness Index: 0.624
- Simpson's Evenness Index: 0.683
- Modified Simpson's Evenness Index: 0.474
- Interspersion/Juxtaposition Index (%): 56.702
- Contagion (%): 51.433
Processing image: subset5.gis
Number of rows, cols: 210, 154
Interior Background Value: 0
Exterior Background Value: 0
Reading 8 bit ERDAS image ....

... 24849 cells of background exterior to the landsca

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<th>Patches</th>
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<td>2512</td>
<td>233</td>
</tr>
<tr>
<td>3</td>
<td>1729</td>
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<td>65</td>
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**LANDSCAPE INDICES**

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<th>Value</th>
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<tr>
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<tr>
<td>Mean Patch Size (ha)</td>
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<tr>
<td>Patch Size Standard Dev (ha)</td>
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<tr>
<td>Patch Size Coefficient of Variation (%)</td>
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<tr>
<td>Mean Edge Contrast Index (%)</td>
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</tr>
<tr>
<td>Area-Weighted Mean Edge Contrast (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Landscape Shape Index</td>
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<tr>
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<td>1.314</td>
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<tr>
<td>Area-Weighted Mean Shape Index</td>
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</tr>
<tr>
<td>Double Log Fractal Dimension</td>
<td>1.459</td>
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<tr>
<td>Mean Patch Fractal Dimension</td>
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<tr>
<td>Area-Weighted Mean Fractal Dimension</td>
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<tr>
<td>Core Area Standard Dev (ha)</td>
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<td>Core Area Coefficient of Variation (%)</td>
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<tr>
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subset
Processing image: subset6.gis
Number of rows, cols: 210, 154
Interior Background Value: 0
Exterior Background Value: 0
Reading 8 bit ERDAS image ....

... 27524 cells of background exterior to the landscape found

<table>
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<tr>
<th>Class</th>
<th>1:</th>
<th>2:</th>
<th>3:</th>
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<th>5:</th>
<th>6:</th>
<th>7:</th>
<th>8:</th>
<th>9:</th>
<th>10:</th>
<th>11:</th>
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<tbody>
<tr>
<td>Cells</td>
<td>369</td>
<td>921</td>
<td>109</td>
<td>957</td>
<td>2567</td>
<td>44</td>
<td>49</td>
<td>44</td>
<td>921</td>
<td>2567</td>
<td>44</td>
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<tr>
<td>Patches</td>
<td>44</td>
<td>43</td>
<td>41</td>
<td>113</td>
<td>113</td>
<td>12</td>
<td>9</td>
<td>12</td>
<td>43</td>
<td>113</td>
<td>12</td>
</tr>
</tbody>
</table>

| LANDSCAPE INDICES |
|--------------------|------------------|
| Total Area (ha): 192,340 |
| Largest Patch Index(%): 14.926 |
| Number of Patches: 295 |
| Patch Density (#/100 ha): 153.125 |
| Mean Patch Size (ha): 0.653 |
| Patch Size Standard Dev (ha): 2.233 |
| Patch Size Coeff of Variation (%): 357.278 |
| Total Edge (m): 74560.000 |
| Edge Density (m/ha): 387.043 |
| Contrast-Weight Edge Density (m/ha): NA |
| Total Edge Contrast Index (t): NA |
| Mean Edge Contrast Index (%): NA |
| Area-Weighted Mean Edge Contrast (%): NA |
| Landscape Shape Index: 12.430 |
| Mean Shape Index: 1.253 |
| Area-Weighted Mean Shape Index: 2.398 |
| Double Log Fractal Dimension: 1.362 |
| Mean Patch Fractal Dimension: 1.043 |
| Area-Weighted Mean Fractal Dimension: 1.144 |
| Total Core Area (ha): 76.560 |
| Number of Core Areas: 72 |
| Core Area Density (#/100 ha): 37.375 |
| Mean Core Area 1 (ha): 0.260 |
| Core Area Standard Dev 1 (ha): 1.330 |
| Core Area Coeff of Variation 1 (%): 512.658 |
| Mean Core Area 2 (ha): 1.063 |
| Core Area Standard Dev 2 (ha): 2.529 |
| Core Area Coeff of Variation 2 (%): 974.641 |
| Total Core Area Index (%): 39.743 |
| Mean Core Area Index (%): 4.219 |
| Mean Nearest Neighbor (m): 56.299 |
| Nearest Neighbor Standard Dev (m): 72.918 |
| Nearest Neigh Coeff of Variation (%): 109.983 |
| Mean Proximity Index: NA |
| Shannon's Diversity Index: 1.259 |
| Simpson's Diversity Index: 0.957 |
| Modified Simpson's Diversity Index: 1.126 |
| Patch Richness: 7 |
| Patch Richness Density (#/100 ha): 1.634 |
| Relative Patch Richness (%): NA |
| Shannon's Evenness Index: 0.698 |
| Simpson's Evenness Index: 0.789 |
... 20795 cells of background exterior to the landscape found

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<tr>
<th>Class</th>
<th>1: 26 cells, 12 patches</th>
<th>2: 1518 cells, 47 patches</th>
<th>3: 37 cells, 16 patches</th>
<th>4: 4205 cells, 143 patches</th>
<th>5: 5242 cells, 104 patches</th>
<th>6: 2 cells, 1 patch</th>
<th>7: 122 cells, 42 patches</th>
<th>8: 393 cells, 29 patches</th>
</tr>
</thead>
<tbody>
<tr>
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<td>max_patch_size: 16992 (background/border patch)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<table>
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<th>Total Area (ha):</th>
<th>461.800</th>
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</thead>
<tbody>
<tr>
<td>Largest Patch Index (t):</td>
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<tr>
<td>Number of patches:</td>
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<tr>
<td>Patch Density (#/100 ha):</td>
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<tr>
<td>Patch Size Standard Dev (ha):</td>
<td>4.012</td>
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<tr>
<td>Patch Size Coeff of Variation (t):</td>
<td>342.297</td>
<td></td>
</tr>
<tr>
<td>Total Edges (m):</td>
<td>154588.500</td>
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<tr>
<td>Edge Density (m/ha):</td>
<td>334.734</td>
<td></td>
</tr>
<tr>
<td>Contrast-Weight Edge Density (m/ha):</td>
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<td></td>
</tr>
<tr>
<td>Total Edge Contrast Index (t):</td>
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<td></td>
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<tr>
<td>Mean Edge Contrast Index (t):</td>
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<td></td>
</tr>
<tr>
<td>Area-Weighted Mean Edge Contrast (t):</td>
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<tr>
<td>Landscape Shape Index:</td>
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<tr>
<td>Mean Shape Index:</td>
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</tr>
<tr>
<td>Area-Weighted Mean Shape Index:</td>
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<td></td>
</tr>
<tr>
<td>Double Log Fractal Dimension:</td>
<td>1.406</td>
<td></td>
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<tr>
<td>Mean Patch Fractal Dimension:</td>
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<tr>
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<tr>
<td>Total Core Area (ha):</td>
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<tr>
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<tr>
<td>Core Area Density (#/100 ha):</td>
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<tr>
<td>Mean Core Area 1 (ha):</td>
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<tr>
<td>Core Area Standard Dev 1 (ha):</td>
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<tr>
<td>Core Area Coeff of Variation 1 (t):</td>
<td>446.084</td>
<td></td>
</tr>
<tr>
<td>Mean Core Area 2 (ha):</td>
<td>1.065</td>
<td></td>
</tr>
<tr>
<td>Core Area Standard Dev 2 (ha):</td>
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<tr>
<td>Core Area Coeff of Variation 2 (t):</td>
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<td>Nearest Neighbor Standard Dev (m):</td>
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<td>Nearest Neighbor Coeff of Variation (t):</td>
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<td>Mean Proximity Index:</td>
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<tr>
<td>Shannon's Diversity Index:</td>
<td>1.190</td>
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<tr>
<td>Simpson's Diversity Index:</td>
<td>0.443</td>
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<tr>
<td>Modified Simpson's Diversity Index:</td>
<td>1.029</td>
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<tr>
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<tr>
<td>Relative Patch Richness (t):</td>
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<tr>
<td>Shannon's Evenness Index:</td>
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</tr>
<tr>
<td>Simpson's Evenness Index:</td>
<td>0.734</td>
<td></td>
</tr>
<tr>
<td>Modified Shannon's Evenness Index:</td>
<td>1.081</td>
<td></td>
</tr>
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</table>
ubset8

Processing image: subset8.gis
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Interior Background Value: 0
Exterior Background Value: 0
Reading 0 bit ERDAS image ....

... 19234 cells of background exterior to the landscape found

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<tr>
<th>Class</th>
<th>1:</th>
<th>113 cells,</th>
<th>42 patches</th>
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<tr>
<td>Class</td>
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<td>2072 cells,</td>
<td>68 patches</td>
</tr>
<tr>
<td>Class</td>
<td>4:</td>
<td>68 cells,</td>
<td>29 patches</td>
</tr>
<tr>
<td>Class</td>
<td>5:</td>
<td>3985 cells,</td>
<td>230 patches</td>
</tr>
<tr>
<td>Class</td>
<td>6:</td>
<td>6244 cells,</td>
<td>124 patches</td>
</tr>
<tr>
<td>Class</td>
<td>9:</td>
<td>442 cells,</td>
<td>114 patches</td>
</tr>
<tr>
<td>Class</td>
<td>10:</td>
<td>220 cells,</td>
<td>30 patches</td>
</tr>
</tbody>
</table>

Number of classes: 7
max patches/class: 730
max_patch_size: 18027 (background/border patch)

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<tr>
<th>Landscape Indices</th>
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<tr>
<td>Total Area (ha): 524.240</td>
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<tr>
<td>Largest Patch Index (%): 18.125</td>
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<tr>
<td>Number of patches: 447</td>
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<td>Patch Density (#/100 ha): 123.417</td>
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<tr>
<td>Mean Patch Size (ha): 0.810</td>
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<tr>
<td>Patch Size Standard Dev (ha): 4.552</td>
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<tr>
<td>Patch Size Coefficient of Variation (%): 541.904</td>
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Total Edge (m): 202620.000

<table>
<thead>
<tr>
<th>Edge Indices</th>
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</thead>
<tbody>
<tr>
<td>Edge Density (m/ha): 386.502</td>
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<tr>
<td>Contrast-Weighted Edge Density (m/ha): NA</td>
</tr>
<tr>
<td>Total Edge Contrast Index (%): NA</td>
</tr>
<tr>
<td>Mean Edge Contrast Index (%): NA</td>
</tr>
<tr>
<td>Area-Weighted Mean Edge Contrast (%): NA</td>
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<tr>
<td>Landscape Shape Index: 22.122</td>
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<tr>
<td>Mean Shape Index: 1.299</td>
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<tr>
<td>Area-Weighted Mean Shape Index: 4.023</td>
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<tr>
<td>Double Log Fragmental Dimension: 1.414</td>
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<tr>
<td>Mean Patch Fractal Dimension: 1.047</td>
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<tr>
<td>Area-Weighted Mean Fractal Dimension: 1.195</td>
</tr>
<tr>
<td>Total Core Area (ha): 192.600</td>
</tr>
<tr>
<td>Number of Core Areas: 229</td>
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<tr>
<td>Core Area Density (#/100 ha): 43.682</td>
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<tr>
<td>Mean Core Area (ha): 0.298</td>
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<tr>
<td>Core Area Standard Dev 1 (ha): 2.219</td>
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<tr>
<td>Core Area Coefficient of Variation 1 (%): 745.498</td>
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<tr>
<td>Mean Core Area 2 (ha): 0.841</td>
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<td>Core Area Standard Dev 2 (ha): 3.668</td>
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<tr>
<td>Core Area Coefficient of Variation 2 (%): 1232.337</td>
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<tr>
<td>Total Core Area Index (%): 36.739</td>
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<tr>
<td>Mean Core Area Index (%): 1.831</td>
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<tr>
<td>Mean Nearest Neighbor (m): 57.814</td>
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<td>Nearest Neighbor Coefficient of Variation (%): 115.207</td>
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<tr>
<td>Shannon's Diversity Index: 1.255</td>
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<tr>
<td>Simpson's Diversity Index: 0.655</td>
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<tr>
<td>Modified Simpson's Diversity Index: 1.064</td>
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<tr>
<td>Patch Richness: 7</td>
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<tr>
<td>Patch Richness Density (#/100 ha): 1.335</td>
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<tr>
<td>Relative Patch Richness (%): NA</td>
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<tr>
<td>Shannon's Evenness Index: 0.645</td>
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<tr>
<td>Simpson's Evenness Index: 0.764</td>
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<tr>
<td>Modified Simpson's Evenness Index: 0.547</td>
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...  19710 cells of background exterior to the landscape found

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<th>1411 cells</th>
<th>97 patches</th>
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<tbody>
<tr>
<td>Class</td>
<td>2</td>
<td>790 cells</td>
<td>36 patches</td>
</tr>
<tr>
<td>Class</td>
<td>3</td>
<td>504 cells</td>
<td>150 patches</td>
</tr>
<tr>
<td>Class</td>
<td>4</td>
<td>4035 cells</td>
<td>194 patches</td>
</tr>
<tr>
<td>Class</td>
<td>5</td>
<td>4655 cells</td>
<td>192 patches</td>
</tr>
<tr>
<td>Class</td>
<td>6</td>
<td>1005 cells</td>
<td>71 patches</td>
</tr>
<tr>
<td>Class</td>
<td>7</td>
<td>150 cells</td>
<td>35 patches</td>
</tr>
</tbody>
</table>

| Class | 8      | 580 cells  | 156 patches|
| Class | 9      | 9750 cells | 364 patches|
| Class | 10     | 450 cells  | 120 patches|
|       |        |            |            |
|       | 505.200|            |            |
|       | 12.151 |            |            |
|       | 775    |            |            |
|       | 153.405|            |            |
|       | 0.652  |            |            |
|       | 3.084  |            |            |
|       | 473.162|            |            |
|       | 232240.000|          |            |
|       | 459.689|            |            |
|       | NA     |            |            |
|       | NA     |            |            |
|       | NA     |            |            |
|       | 25.831 |            |            |
|       | 1.321  |            |            |
|       | 3.341  |            |            |
|       | 1.435  |            |            |
|       | 1.051  |            |            |
|       | 1.183  |            |            |
|       | 152.600|            |            |
|       | 262    |            |            |
|       | 51.981 |            |            |
|       | 0.198  |            |            |
|       | 1.496  |            |            |
|       | 755.027|            |            |
|       | 0.586  |            |            |
|       | 2.529  |            |            |
|       | 2275.066|          |            |
|       | 0.404  |            |            |
|       | 3.623  |            |            |
|       | 61.713 |            |            |
|       | 87.408 |            |            |
|       | 141.636|            |            |
|       | NA     |            |            |
|       | NA     |            |            |
|       | NA     |            |            |
|       | 1.347  |            |            |
|       | 0.737  |            |            |
|       | 1.335  |            |            |
|       | 1.396  |            |            |
|       | NA     |            |            |
|       | 0.793  |            |            |
|       | 0.860  |            |            |
|       | 0.687  |            |            |
|       | 63.214 |            |            |
|       | 43.521 |            |            |

**LANDSCAPE INDICES**

- Total Area (ha): 505.200
- Largest Patch Index (%): 12.151
- Number of patches: 775
- Patch Density (%/100 ha): 153.405
- Mean Patch Size (ha): 0.652
- Patch Size Standard Dev (ha): 3.084
- Patch Coefficient of Variation (%): 473.162
- Total Edge (m): 232240.000
- Edge Density (m/ha): 459.689
- Total Edge Contrast Index (%): NA
- Mean Edge Contrast Index (%): NA
- Area-Weighted Mean Edge Contrast (%): NA
- Landscape Shape Index: 25.831
- Mean Shape Index: 1.321
- Area-Weighted Mean Shape Index: 3.341
- Double Log Fractal Dimension: 1.435
- Mean Patch Fractal Dimension: 1.051
- Area-Weighted Mean Fractal Dimension: 1.183
- Total Core Area (ha): 152.600
- Number of Core Areas: 262
- Core Area Density (%/100 ha): 51.981
- Mean Core Area 1 (ha): 0.198
- Core Area Standard Dev 1 (ha): 1.496
- Core Area Coefficient of Variation 1 (%): 755.027
- Mean Core Area 2 (ha): 0.586
- Core Area Standard Dev 2 (ha): 2.529
- Core Area Coefficient of Variation 2 (%): 2275.066
- Total Core Area Index (%): 0.404
- Mean Core Area Index (%): 3.623
- Mean Nearest Neighbor (s): 61.713
- Nearest Neighbor Standard Dev (s): 87.408
- Nearest Neighbor Coefficient of Variation (%): 141.636
- Mean Proximity Index: NA
- Shannon's Diversity Index: 1.347
- Simpson's Diversity Index: 0.737
- Modified Simpson's Diversity Index: 1.335
- Patch Richness Index: 1.396
- Relative Patch Richness (%): NA
- Shannon's Evenness Index: 0.793
- Simpson's Evenness Index: 0.860
- Modified Simpson's Evenness Index: 0.687
- Interpersion/Interposition Index (%): 63.214
- Contagion (%): 43.521
... 23823 cells of background exterior to the landscape found

<table>
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<th>Class</th>
<th>Cells</th>
<th>Patches</th>
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<td>78</td>
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<tr>
<td>4</td>
<td>521</td>
<td>63</td>
</tr>
<tr>
<td>5</td>
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<td>1130</td>
<td>78</td>
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<tr>
<td>10</td>
<td>46</td>
<td>15</td>
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</tbody>
</table>

number of classes: 6
max patches/class: 140
max_patch_size: 23104 (background/border patch)

<table>
<thead>
<tr>
<th>Landscape Indices</th>
<th>Value</th>
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<tr>
<td>Total Area (ha)</td>
<td>340.680</td>
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<tr>
<td>Largest Patch Index (%)</td>
<td>14.066</td>
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<tr>
<td>Number of patches</td>
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<tr>
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<tr>
<td>Mean Patch Size (ha)</td>
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<tr>
<td>Patch Size Standard Dev (ha)</td>
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<tr>
<td>Total Edge (m)</td>
<td>151840.000</td>
</tr>
<tr>
<td>Edge Density (m/ha)</td>
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<tr>
<td>Contrast-Weight Edge Density (m/ha)</td>
<td>NA</td>
</tr>
<tr>
<td>Total Edge Contrast Index (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Mean Edge Contrast Index (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Area-Weighted Mean Edge Contrast (%)</td>
<td>NA</td>
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<tr>
<td>Landscape Shape Index</td>
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<tr>
<td>Mean Shape Index</td>
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<tr>
<td>Total Core Area (ha)</td>
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<tr>
<td>Core Area Density (#/100 ha)</td>
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<tr>
<td>Mean Core Area 1 (ha)</td>
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<tr>
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<td>Core Area Coeff of Variation 1 (%)</td>
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<tr>
<td>Shannon's Diversity Index</td>
<td>1.390</td>
</tr>
<tr>
<td>Simpson's Diversity Index</td>
<td>0.707</td>
</tr>
<tr>
<td>Modified Simpson's Diversity Index</td>
<td>1.208</td>
</tr>
<tr>
<td>Patch Richness</td>
<td>6</td>
</tr>
<tr>
<td>Patch Richness Density (#/100 ha)</td>
<td>1.761</td>
</tr>
<tr>
<td>Relative Patch Richness (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Shannon's Evenness Index</td>
<td>0.776</td>
</tr>
<tr>
<td>Simpson's Evenness Index</td>
<td>0.844</td>
</tr>
<tr>
<td>Modified Simpson's Evenness Index</td>
<td>0.674</td>
</tr>
<tr>
<td>Interspersion/Intrusion Index (%)</td>
<td>62.283</td>
</tr>
<tr>
<td>Contagion (%)</td>
<td>43.008</td>
</tr>
</tbody>
</table>
... 18904 cells of background exterior to the landscape found

<table>
<thead>
<tr>
<th>Class</th>
<th>Cells</th>
<th>Patches</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6378</td>
<td>167</td>
</tr>
<tr>
<td>2</td>
<td>661</td>
<td>129</td>
</tr>
<tr>
<td>4</td>
<td>2735</td>
<td>220</td>
</tr>
<tr>
<td>5</td>
<td>2616</td>
<td>170</td>
</tr>
<tr>
<td>6</td>
<td>715</td>
<td>45</td>
</tr>
<tr>
<td>9</td>
<td>131</td>
<td>50</td>
</tr>
</tbody>
</table>

**LANDSCAPE INDICES**

- Total Area (ha): 537.440
- Largest Patch Index (%): 13.11
- Number of patches: 793
- Patch Density (#/100 ha): 147.551
- Mean Patch Size (ha): 0.678
- Patch Size Standard Dev (ha): 4.877
- Patch Size Coeff of Variation (%): 719.588
- Total Edge (m): 190420.000
- Edge Density (m/ha): 354.309
- Contrast-Weight Edge Density (m/ha): NA
- Total Edge Contrast Index (%): NA
- Mean Edge Contrast Index (%): NA
- Area-Weighted Mean Edge Contrast (%): NA
- Landscape Shape Index: 20.535
- Mean Shape Index: 1.308
- Area-Weighted Mean Shape Index: 3.775
- Double Log Fractal Dimension: 1.448
- Mean Patch Fractal Dimension: 1.050
- Area-Weighted Mean Fractal Dimension: 1.188
- Total Core Area (ha): 168.800
- Number of Core Areas: 300
- Core Area Density (#/100 ha): 55.820
- Mean Core Area 1 (ha): 0.213
- Core Area Standard Dev 1 (ha): 2.924
- Core Area Coeff of Variation 1 (%): 1373.651
- Mean Core Area 2 (ha): 0.563
- Core Area Standard Dev 2 (ha): 4.733
- Core Area Coeff of Variation 2 (%): 2023.560
- Total Core Area Index (%): 31.408
- Mean Core Area Index (%): 3.255
- Mean Nearest Neighbor (m): 51.197
- Nearest Neighbor Standard Dev (m): 56.025
- Nearest Neigh Coeff of Variation (%): 109.430
- Mean Proximity Index: NA
- Shannon's Diversity Index: 1.374
- Simpson's Diversity Index: 0.688
- Modified Simpson's Diversity Index: 1.146
- Patch Richness: 5
- Patch Richness Density (#/100 ha): 1.116
- Relative Patch Richness (%): NA
- Shannon's Evenness Index: 0.767
- Simpson's Evenness Index: 0.826
- Modified Simpson's Evenness Index: 0.651
- Interspersion/Justposition Index (%): 73.515
Subset 2

Processing image: subset2.gis
Number of rows, cols: 210, 154
Interior Background Value: 0
Exterior Background Value: 0
Reading 8 bit ERDAS image ....

... 22660 cells of background exterior to the landscape found

| Class | 1:   1175 cells, 135 patches |
| Class | 2:   480 cells, 115 patches   |
| Class | 4:   1834 cells, 182 patches  |
| Class | 5:   5106 cells, 197 patches  |
| Class | 6:   752 cells, 73 patches    |
| Class | 9:   133 cells, 16 patches    |

LANDSCAPE INDICES

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Area (ha)</td>
<td>379.200</td>
</tr>
<tr>
<td>Largest Patch Index (%)</td>
<td>17.816</td>
</tr>
<tr>
<td>Number of patches</td>
<td>718</td>
</tr>
<tr>
<td>Patch Density (#/100 ha)</td>
<td>189.346</td>
</tr>
<tr>
<td>Mean Patch Size (ha)</td>
<td>0.528</td>
</tr>
<tr>
<td>Patch Size Standard Dev (ha)</td>
<td>2.962</td>
</tr>
<tr>
<td>Patch Size Coef of Variation (%)</td>
<td>560.810</td>
</tr>
<tr>
<td>Total Edge (m)</td>
<td>171320.000</td>
</tr>
<tr>
<td>Edge Density (m/ha)</td>
<td>451.793</td>
</tr>
<tr>
<td>Contrast-Weight Edge Density (m/ha)</td>
<td>NA</td>
</tr>
<tr>
<td>Total Edge Contrast Index (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Mean Edge Contrast Index (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Area-Weighted Mean Edge Contrast (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Landscape Shape Index</td>
<td>21.994</td>
</tr>
<tr>
<td>Mean Shape Index</td>
<td>1.274</td>
</tr>
<tr>
<td>Area-Weighted Mean Shape Index</td>
<td>3.190</td>
</tr>
<tr>
<td>Double Log Fractal Dimension</td>
<td>1.418</td>
</tr>
<tr>
<td>Mean Patch Fractal Dimension</td>
<td>1.346</td>
</tr>
<tr>
<td>Area-Weighted Mean Fractal Dimension</td>
<td>1.168</td>
</tr>
<tr>
<td>Total Core Area (ha)</td>
<td>105.160</td>
</tr>
<tr>
<td>Number of Core Areas</td>
<td>227</td>
</tr>
<tr>
<td>Core Area Density (#/100 ha)</td>
<td>59.863</td>
</tr>
<tr>
<td>Mean Core Area 1 (ha)</td>
<td>0.146</td>
</tr>
<tr>
<td>Core Area Standard Dev 1 (ha)</td>
<td>1.521</td>
</tr>
<tr>
<td>Core Area Coeff of Variation 1 (%)</td>
<td>1038.434</td>
</tr>
<tr>
<td>Mean Core Area 2 (ha)</td>
<td>0.443</td>
</tr>
<tr>
<td>Core Area Standard Dev 2 (ha)</td>
<td>2.578</td>
</tr>
<tr>
<td>Core Area Coeff of Variation 2 (%)</td>
<td>1828.219</td>
</tr>
<tr>
<td>Total Core Area Index (%)</td>
<td>27.732</td>
</tr>
<tr>
<td>Mean Core Area Index (%)</td>
<td>3.053</td>
</tr>
<tr>
<td>Mean Nearest Neighbor (m)</td>
<td>54.881</td>
</tr>
<tr>
<td>Nearest Neighbor Standard Dev (m)</td>
<td>69.168</td>
</tr>
<tr>
<td>Nearest Neigh Coeff of Variation (%)</td>
<td>126.032</td>
</tr>
<tr>
<td>Mean Proximity Index</td>
<td>NA</td>
</tr>
<tr>
<td>Shannon's Diversity Index</td>
<td>1.322</td>
</tr>
<tr>
<td>Simpson’s Diversity Index</td>
<td>0.848</td>
</tr>
<tr>
<td>Modified Simpson’s Diversity Index</td>
<td>1.044</td>
</tr>
<tr>
<td>Patch Richness</td>
<td>6</td>
</tr>
<tr>
<td>Patch Richness Density (#/100 ha)</td>
<td>1.582</td>
</tr>
<tr>
<td>Relative Patch Richness (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Shannon’s Evenness Index</td>
<td>0.738</td>
</tr>
<tr>
<td>Simpson’s Evenness Index</td>
<td>0.778</td>
</tr>
<tr>
<td>Modified Simpson’s Evenness Index</td>
<td>0.583</td>
</tr>
</tbody>
</table>
**SubSet3**

Processing image: subsect3.gis

Number of rows, cols: 210, 154

Interior Background Value: 0

Exterior Background Value: 0

Reading 8 bit ERDAS image ....

... 15553 cells of background exterior to the landscape found

<table>
<thead>
<tr>
<th>Class</th>
<th>Cells</th>
<th>Patches</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5410</td>
<td>377</td>
</tr>
<tr>
<td>2</td>
<td>1335</td>
<td>190</td>
</tr>
<tr>
<td>3</td>
<td>4457</td>
<td>358</td>
</tr>
<tr>
<td>4</td>
<td>4433</td>
<td>301</td>
</tr>
<tr>
<td>6</td>
<td>471</td>
<td>101</td>
</tr>
<tr>
<td>9</td>
<td>281</td>
<td>71</td>
</tr>
</tbody>
</table>

Number of classes: 6

Max patches/class: 377

Max patch size: 7950 (background/border patch)

**LANDSCAPE INDICES**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Area (ha):</td>
<td>671.480</td>
</tr>
<tr>
<td>Largest Patch Index (1):</td>
<td>4.372</td>
</tr>
<tr>
<td>Number of patches:</td>
<td>1398</td>
</tr>
<tr>
<td>Patch Density (#/100 ha):</td>
<td>208.197</td>
</tr>
<tr>
<td>Mean Patch Size (ha):</td>
<td>0.480</td>
</tr>
<tr>
<td>Patch Size Standard Dev (ha):</td>
<td>1.735</td>
</tr>
<tr>
<td>Patch Size Coeff of Variation (1):</td>
<td>361.262</td>
</tr>
<tr>
<td>Total Edge (m):</td>
<td>3122.400</td>
</tr>
<tr>
<td>Edge Density (m/ha):</td>
<td>465.003</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Contrast-Weighted Edge Density (m/ha):</td>
<td>NA</td>
</tr>
<tr>
<td>Total Edge Contrast Index (1):</td>
<td>NA</td>
</tr>
<tr>
<td>Mean Edge Contrast Index (1):</td>
<td>NA</td>
</tr>
<tr>
<td>Area-Weighted Mean Edge Contrast (1):</td>
<td>NA</td>
</tr>
<tr>
<td>Landscape Shape Index:</td>
<td>30.124</td>
</tr>
<tr>
<td>Mean Shape Index:</td>
<td>1.309</td>
</tr>
<tr>
<td>Area-Weighted Mean Shape Index:</td>
<td>2.802</td>
</tr>
<tr>
<td>Double Log Fractal Dimension:</td>
<td>1.450</td>
</tr>
<tr>
<td>Mean Patch Fractal Dimension:</td>
<td>1.051</td>
</tr>
<tr>
<td>Area-Weighted Mean Fractal Dimension:</td>
<td>1.162</td>
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<tr>
<td>Total Core Area (ha):</td>
<td>134.680</td>
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<td>Number of Core Areas:</td>
<td>454</td>
</tr>
<tr>
<td>Core Area Density (#/100 ha):</td>
<td>67.612</td>
</tr>
<tr>
<td>Mean Core Area 1 (ha):</td>
<td>0.096</td>
</tr>
<tr>
<td>Core Area Standard Dev 1 (ha):</td>
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</tr>
<tr>
<td>Core Area Coeff of Variation 1 (1):</td>
<td>726.671</td>
</tr>
<tr>
<td>Mean Core Area 2 (ha):</td>
<td>0.297</td>
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<tr>
<td>Core Area Standard Dev 2 (ha):</td>
<td>1.204</td>
</tr>
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<td>1249.798</td>
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<tr>
<td>Total Core Area Index (1):</td>
<td>20.057</td>
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<tr>
<td>Mean Core Area Index (1):</td>
<td>2.867</td>
</tr>
<tr>
<td>Mean Nearest Neighbor (m):</td>
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</tr>
<tr>
<td>Nearest Neighbor Standard Dev (m):</td>
<td>55.023</td>
</tr>
<tr>
<td>Nearest Neighbor Coeff of Variation (1):</td>
<td>115.799</td>
</tr>
<tr>
<td>Mean Proximity Index:</td>
<td>NA</td>
</tr>
<tr>
<td>Shannon’s Diversity Index:</td>
<td>1.492</td>
</tr>
<tr>
<td>Simpson’s Diversity Index:</td>
<td>0.747</td>
</tr>
<tr>
<td>Modified Simpson’s Diversity Index:</td>
<td>1.373</td>
</tr>
<tr>
<td>Patch Richness:</td>
<td>6</td>
</tr>
<tr>
<td>Patch Richness Density (#/100 ha):</td>
<td>0.894</td>
</tr>
<tr>
<td>Relative Patch Richness (1):</td>
<td>NA</td>
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<tr>
<td>Shannon’s Evenness Index:</td>
<td>0.833</td>
</tr>
<tr>
<td>Simpson’s Evenness Index:</td>
<td>0.896</td>
</tr>
<tr>
<td>Modified Simpson’s Evenness Index:</td>
<td>0.756</td>
</tr>
<tr>
<td>Interspersion/Interposition Index (1):</td>
<td>73.486</td>
</tr>
<tr>
<td>Contagion (1):</td>
<td>31.824</td>
</tr>
</tbody>
</table>
### LANDSCAPE INDICES

<table>
<thead>
<tr>
<th>Class</th>
<th>Cells</th>
<th>Patches</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7016</td>
<td>337</td>
</tr>
<tr>
<td>2</td>
<td>16</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>14318</td>
<td>368</td>
</tr>
<tr>
<td>5</td>
<td>2690</td>
<td>250</td>
</tr>
<tr>
<td>6</td>
<td>1051</td>
<td>103</td>
</tr>
<tr>
<td>9</td>
<td>187</td>
<td>69</td>
</tr>
</tbody>
</table>

Number of classes: 6

Max patches/class: 366

Max patch size: 7643 (background/border patch)

... 17062 cells of background exterior to the landscape found
**Processing image: subset5.gis**

- **Number of rows, cols:** 210, 134
- **Interior Background Value:** 0
- **Exterior Background Value:** 0
- **Reading 8 bit ERDAS image**

... 15899 cells of background exterior to the landscape found

<table>
<thead>
<tr>
<th>Class</th>
<th>4759 cells</th>
<th>301 patches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 4</td>
<td>5404 cells</td>
<td>375 patches</td>
</tr>
<tr>
<td>Class 5</td>
<td>4505 cells</td>
<td>251 patches</td>
</tr>
<tr>
<td>Class 6</td>
<td>940 cells</td>
<td>133 patches</td>
</tr>
<tr>
<td>Class 7</td>
<td>836 cells</td>
<td>156 patches</td>
</tr>
</tbody>
</table>

**Number of classes:** 5

**max patches/class:** 375

**max_patch_size:** 9702 (background/border patch)

**LANDSCAPE INDICES**

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Area (ha)</td>
<td>657.760</td>
</tr>
<tr>
<td>Largest Patch Index (%)</td>
<td>6.312</td>
</tr>
<tr>
<td>Number of patches</td>
<td>1116</td>
</tr>
<tr>
<td>Patch Density (#/100 ha)</td>
<td>177.268</td>
</tr>
<tr>
<td>Mean Patch Size (ha)</td>
<td>0.564</td>
</tr>
<tr>
<td>Patch Size Standard Dev (ha)</td>
<td>2.941</td>
</tr>
<tr>
<td>Patch Size Coef of Variation (%)</td>
<td>3.803</td>
</tr>
<tr>
<td>Total Edge (m)</td>
<td>291020.000</td>
</tr>
<tr>
<td>Edge Density (m/ha)</td>
<td>442.441</td>
</tr>
<tr>
<td>Contrast-Weight Edge Density (m/ha)</td>
<td>NA</td>
</tr>
<tr>
<td>Total Edge Contrast Index (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Mean Edge Contrast Index (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Area-Weighted Mean Edge Contrast (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Landscape Shape Index</td>
<td>26.368</td>
</tr>
<tr>
<td>Mean Shape Index</td>
<td>1.34</td>
</tr>
<tr>
<td>Area-Weighted Mean Shape Index</td>
<td>3.653</td>
</tr>
<tr>
<td>Double Log Fractal Dimension</td>
<td>1.446</td>
</tr>
<tr>
<td>Mean Patch Fractal Dimension</td>
<td>1.054</td>
</tr>
<tr>
<td>Area-Weighted Mean Fractal Dimension</td>
<td>1.174</td>
</tr>
<tr>
<td>Total Core Area (ha)</td>
<td>144.600</td>
</tr>
<tr>
<td>Number of Core Areas</td>
<td>438</td>
</tr>
<tr>
<td>Core Area Density (#/100 ha)</td>
<td>66.590</td>
</tr>
<tr>
<td>Mean Core Area (ha)</td>
<td>0.121</td>
</tr>
<tr>
<td>Core Area Standard Dev (ha)</td>
<td>0.793</td>
</tr>
<tr>
<td>Core Area Coef of Variation (1 %)</td>
<td>652.793</td>
</tr>
<tr>
<td>Mean Core Area 2 (ha)</td>
<td>0.223</td>
</tr>
<tr>
<td>Core Area Standard Dev 2 (ha)</td>
<td>1.256</td>
</tr>
<tr>
<td>Core Area Coef of Variation 2 (%)</td>
<td>1044.115</td>
</tr>
<tr>
<td>Total Core Area Index (%)</td>
<td>21.528</td>
</tr>
<tr>
<td>Mean Core Area Index (%)</td>
<td>3.278</td>
</tr>
<tr>
<td>Mean Nearest Neighbor (m)</td>
<td>41.050</td>
</tr>
<tr>
<td>Nearest Neighbor Standard Dev (m)</td>
<td>38.278</td>
</tr>
<tr>
<td>Nearest Neighbors Coef of Variation (%)</td>
<td>93.248</td>
</tr>
<tr>
<td>Mean Proximity Index</td>
<td>NA</td>
</tr>
<tr>
<td>Shannon's Diversity Index</td>
<td>1.394</td>
</tr>
<tr>
<td>Simpson's Diversity Index</td>
<td>0.737</td>
</tr>
<tr>
<td>Modified Simpson's Diversity Index</td>
<td>1.300</td>
</tr>
<tr>
<td>Patch Richness</td>
<td>5</td>
</tr>
<tr>
<td>Patch Richness Density (#/100 ha)</td>
<td>0.740</td>
</tr>
<tr>
<td>Relative Patch Richness (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Shannon's Evenness Index</td>
<td>0.866</td>
</tr>
<tr>
<td>Simpson's Evenness Index</td>
<td>0.909</td>
</tr>
<tr>
<td>Modified Simpson's Evenness Index</td>
<td>0.807</td>
</tr>
<tr>
<td>Interspersion/Juxtaposition Index (%)</td>
<td>74.082</td>
</tr>
<tr>
<td>Contagion (%)</td>
<td>29.029</td>
</tr>
</tbody>
</table>
Subset 6

Processing image: subset6.jpg
Number of rows, cols: 210, 154
Interior Background Value: 0
Exterior Background Value: 0
Reading 8 bit ERDAS image ....

... 22667 cells of background exterior to the landscape found

<table>
<thead>
<tr>
<th>Class</th>
<th>2417 cells</th>
<th>91 patches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 2</td>
<td>750 cells</td>
<td>74 patches</td>
</tr>
<tr>
<td>Class 3</td>
<td>1082 cells</td>
<td>97 patches</td>
</tr>
<tr>
<td>Class 4</td>
<td>2550 cells</td>
<td>173 patches</td>
</tr>
<tr>
<td>Class 5</td>
<td>2294 cells</td>
<td>128 patches</td>
</tr>
<tr>
<td>Class 6</td>
<td>70 cells</td>
<td>25 patches</td>
</tr>
<tr>
<td>Class 7</td>
<td>510 cells</td>
<td>19 patches</td>
</tr>
</tbody>
</table>

number of classes: 7
max patch_size: 21264 (background/border patch)

LANDSCAPE INDICES

| Total Area (ha): | 386.120 |
| Largest Patch Index (%): | 15.416 |
| Number of patches: | 407 |
| Patch Density (#/100 ha): | 157.295 |
| Mean Patch Size (ha): | 0.436 |
| Patch Size Standard Dev (ha): | 2.780 |
| Patch Size Coeff of Variation (%): | 437.062 |
| Total Edge (a): | 151720.000 |
| Edge Density (w/ha): | 392.935 |
| Contrast-Weight Edge Density (w/ha): | NA |
| Total Edge Contrast Index (%): | NA |
| Mean Edge Contrast Index (%): | NA |
| Area-Weighted Mean Edge Contrast (%): | NA |
| Landscape Shape Index: | 19.303 |
| Mean Shape Index: | 1.334 |
| Area-Weighted Mean Shape Index: | 3.051 |
| Double Log Fractal Dimension: | 1.451 |
| Mean Patch Fractal Dimension: | 1.052 |
| Area-Weighted Mean Fractal Dimension: | 1.171 |
| Total Core Area (ha): | 102,340 |
| Number of Core Areas: | 237 |
| Core Area Density (#/100 ha): | 61.380 |
| Mean Core Area (ha): | 0.166 |
| Core Area Standard Dev 1 (ha): | 1.292 |
| Core Area Coeff of Variation 1 (%): | 875.218 |
| Mean Core Area 2 (ha): | 0.432 |
| Core Area Standard Dev 2 (ha): | 3.202 |
| Core Area Coeff of Variation 2 (%): | 1306.236 |
| Total Core Area Index (%): | 26.519 |
| Mean Core Area Index (%): | 1.821 |
| Mean Nearest Neighbor (a): | 50.494 |
| Nearest Neighbor Standard Dev (a): | 64.737 |
| Nearest Neighbor Coefficient of Variation (%): | 116,971 |
| Mean Proximity Index: | NA |
| Shannon's Diversity Index: | 1.672 |
| Simpson's Diversity Index: | 0.760 |
| Modified Simpson's Diversity Index: | 1.560 |
| Patch Richness: | 7 |
| Patch Richness Density (#/100 ha): | 1.512 |
| Relative Patch Richness (%): | NA |
| Shannon's Evenness Index: | 0.859 |
| Simpson's Evenness Index: | 0.922 |
| Modified Simpson's Evenness Index: | 0.922 |
| Interdispersion/Interposition Index (%): | 71.711 |
| Contagion (%): | 32.581 |
Processing image: subset7.gis
Number of rows, cols: 210, 154
Interior Background Value: 0
Exterior Background Value: 0
Reading 8 bit ERDAS image ....

.... 23215 cells of background exterior to the landscape found

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<th># Cells</th>
<th># Patches</th>
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<td>15</td>
</tr>
<tr>
<td>2</td>
<td>695</td>
<td>66</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>28</td>
</tr>
<tr>
<td>4</td>
<td>3222</td>
<td>200</td>
</tr>
<tr>
<td>5</td>
<td>3197</td>
<td>257</td>
</tr>
<tr>
<td>6</td>
<td>574</td>
<td>56</td>
</tr>
<tr>
<td>7</td>
<td>1255</td>
<td>39</td>
</tr>
</tbody>
</table>

Number of classes: 7
mean patches/class: 257
mean patch size: 22680 (background/border patch)

<table>
<thead>
<tr>
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<th>Value</th>
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<tbody>
<tr>
<td>Total Area (ha)</td>
<td>365.00</td>
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<tr>
<td>Largest Patch Index (%)</td>
<td>8.351</td>
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<tr>
<td>Number of patches</td>
<td>661</td>
</tr>
<tr>
<td>Patch Density (#/100 ha)</td>
<td>181.096</td>
</tr>
<tr>
<td>Mean Patch Size (ha)</td>
<td>0.552</td>
</tr>
<tr>
<td>Patch Size Standard Dev (ha)</td>
<td>1.913</td>
</tr>
<tr>
<td>Patch Size Coef of Variation (%)</td>
<td>346.946</td>
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<tr>
<td>Total Edge (m)</td>
<td>165440.000</td>
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<tr>
<td>Edge Density (m/ha)</td>
<td>453.315</td>
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<tr>
<td>Contrast-Weight Edge Density (m/ha)</td>
<td>NA</td>
</tr>
<tr>
<td>Total Edge Contrast Index (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Mean Edge Contrast Index (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Area-Weighted Mean Edge Contrast (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Landscape Shape Index</td>
<td>21.651</td>
</tr>
<tr>
<td>Mean Shape Index</td>
<td>1.281</td>
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<tr>
<td>Area-Weighted Mean Shape Index</td>
<td>2.267</td>
</tr>
<tr>
<td>Double Log Fractal Dimension</td>
<td>1.389</td>
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<tr>
<td>Mean Patch Fractal Dimension</td>
<td>1.048</td>
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<tr>
<td>Area-Weighted Mean Fractal Dimension</td>
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<td>Total Core Area (ha)</td>
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<tr>
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<tr>
<td>Core Area Standard Dev 1 (ha)</td>
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</tr>
<tr>
<td>Core Area Coeff of Variation 1 (%)</td>
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<tr>
<td>Mean Core Area 2 (ha)</td>
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<tr>
<td>Core Area Standard Dev 2 (ha)</td>
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<tr>
<td>Core Area Coeff of Variation 2 (%)</td>
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<td>Mean Core Area Index (%)</td>
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<td>Shannon's Diversity Index</td>
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<tr>
<td>Simpson's Diversity Index</td>
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<tr>
<td>Modified Simpson's Diversity Index</td>
<td>1.286</td>
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<tr>
<td>Patch Richness Density (#/100 ha)</td>
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<tr>
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<td>NA</td>
</tr>
<tr>
<td>Shannon's Evenness Index</td>
<td>0.735</td>
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<tr>
<td>Simpson's Evenness Index</td>
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<td>Interspersion/Interposition Index (%)</td>
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<tr>
<td>Contagion (%)</td>
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Number of rows, cols: 210, 154  
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Exterior Background Value: 0  
Reading 8 bit ERDAS image ....  

... 13336 cells of background exterior to the landscape found

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<tr>
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<th>609 cells</th>
<th>65 patches</th>
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<tbody>
<tr>
<td>Class 2</td>
<td>2352 cells</td>
<td>140 patches</td>
</tr>
<tr>
<td>Class 3</td>
<td>584 cells</td>
<td>92 patches</td>
</tr>
<tr>
<td>Class 4</td>
<td>14832 cells</td>
<td>319 patches</td>
</tr>
<tr>
<td>Class 5</td>
<td>5166 cells</td>
<td>335 patches</td>
</tr>
<tr>
<td>Class 6</td>
<td>1571 cells</td>
<td>138 patches</td>
</tr>
<tr>
<td>Class 7</td>
<td>1890 cells</td>
<td>39 patches</td>
</tr>
</tbody>
</table>

Number of classes: 7  
Areas patches/class: 225  
Areas_patch_size: 6793 (background/border patch)  

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<tr>
<th>LANDSCAPE INDICES</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Area (ha):</td>
<td>690.160</td>
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<tr>
<td>Largest Patch Index (t):</td>
<td>6.151</td>
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<tr>
<td>Number of patches:</td>
<td>1128</td>
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<tr>
<td>Patch Density (#/100 ha):</td>
<td>165.843</td>
</tr>
<tr>
<td>Mean Patch Size (ha):</td>
<td>0.600</td>
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<tr>
<td>Patch Size Standard Dev (ha):</td>
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<tr>
<td>Patch Size Coeff of Variation (%):</td>
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<tr>
<td>Total Edge (a):</td>
<td>207700.000</td>
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<td>Edge Density (a/ha):</td>
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<tr>
<td>Contrast-Weight Edge Density (a/ha):</td>
<td>NA</td>
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<tr>
<td>Total Edge Contrast Index (t):</td>
<td>NA</td>
</tr>
<tr>
<td>Mean Edge Contrast Index (%):</td>
<td>NA</td>
</tr>
<tr>
<td>Area-Weighted Mean Edge Contrast (t):</td>
<td>NA</td>
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<tr>
<td>Landscape Shape Index:</td>
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<tr>
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<td>Area-Weighted Mean Shape Index:</td>
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<td>Double Log Fractal Dimension:</td>
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<tr>
<td>Mean Patch Fractal Dimension:</td>
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<tr>
<td>Area-Weighted Mean Fractal Dimension:</td>
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<tr>
<td>Total Core Area (ha):</td>
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<tr>
<td>Shannon's Diversity Index:</td>
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<tr>
<td>Simpson's Diversity Index:</td>
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<tr>
<td>Modified Simpson's Diversity Index:</td>
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<tr>
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<tr>
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<td>Interassociation/Interdependence Index (t):</td>
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<td>Contagion (t):</td>
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</table>
**Processing image: subset9.gis**

Number of rows, cols: 210, 154

Interior Background Value: 0

Exterior Background Value: 0

Reading 8 bit ERAS image ... 

... 14297 cells of background exterior to the landscape found

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<td>166</td>
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<tr>
<td>2</td>
<td>657</td>
<td>99</td>
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<tr>
<td>3</td>
<td>1537</td>
<td>222</td>
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<tr>
<td>4</td>
<td>4864</td>
<td>385</td>
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<td>5</td>
<td>5722</td>
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<td>153</td>
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<td>7</td>
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**LANDSCAPE INDICES**

<table>
<thead>
<tr>
<th>Index</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Total Area (ha)</td>
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<tr>
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<tr>
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<tr>
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</tr>
<tr>
<td>Mean Patch Size (ha)</td>
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<tr>
<td>Patch Size Standard Dev (ha)</td>
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<tr>
<td>Patch Size Coef of Variation (%)</td>
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</tr>
<tr>
<td>Total Edge (a)</td>
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<tr>
<td>Edge Density (a/ha)</td>
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<tr>
<td>Contrast-Weight Edge Density (a/ha)</td>
<td>NA</td>
</tr>
<tr>
<td>Total Edge Contrast Index (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Mean Edge Contrast Index (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Area-Weighted Mean Edge Contrast (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Landscape Shape Index</td>
<td>30.862</td>
</tr>
<tr>
<td>Mean Shape Index</td>
<td>1.327</td>
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<tr>
<td>Area-Weighted Mean Shape Index</td>
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<tr>
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<td>Mean Patch Fractal Dimension</td>
<td>1.053</td>
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<tr>
<td>Core Area Density (#/100 ha)</td>
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<tr>
<td>Core Area Coef of Variation 1 (%)</td>
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<tr>
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<td>Core Area Coef of Variation 2 (%)</td>
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<tr>
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<tr>
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<tr>
<td>Relative Patch Richness (%)</td>
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<tr>
<td>Modified Simpson's Evenness Index</td>
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<tr>
<td>Interception/Exposition Index (%)</td>
<td>73.227</td>
</tr>
<tr>
<td>Contagion (%)</td>
<td>33.257</td>
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</table>
... 19846 cells of background exterior to the landscape found

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<th>Cells</th>
<th>Patches</th>
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<tr>
<td>2</td>
<td>8</td>
<td>4</td>
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<tr>
<td>4</td>
<td>1604</td>
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<td>9</td>
<td>1213</td>
<td>103</td>
</tr>
<tr>
<td>10</td>
<td>691</td>
<td>21</td>
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</tbody>
</table>

**LANDSCAPE INDICES**

- Total Area (ha): 1524.20
- Largest Patch Index (%): 3.714
- Number of patches: 919
- Patch Density (/100 ha): 137.388
- Mean Patch Size (ha): 0.544
- Patch Size Standard Dev (ha): 1.357
- Total Edge (m): 22966.00
- Edge Density (m/ha): 459.541
- Contrast-Weight Edge Density (m/ha): NA
- Total Edge Contrast Index (%): NA
- Mean Edge Contrast Index (%): NA
- Landscape Shape Index: 25.683
- Mean Shape Index: 1.325
- Area-Weighted Mean Shape Index: 2.633
- Double Log Fractal Dimension: 1.452
- Mean Patch Fractal Dimension: 1.053
- Area-Weighted Mean Fractal Dimension: 1.161
- Core Area (ha): 104.040
- Number of Core Areas: 343
- Core Area Density (/100 ha): 68.633
- Mean Core Area 1 (ha): 0.113
- Core Area Standard Dev 1 (ha): 0.594
- Core Area Coeff of Variation 1 (%): 52.874
- Mean Core Area 2 (ha): 0.303
- Core Area Standard Dev 2 (ha): 0.942
- Core Area Coeff of Variation 2 (%): 83.547
- Total Core Area Index (%): 20.918
- Mean Core Area Index (%): 3.546
- Mean Nearest Neighbor (m): 44.875
- Nearest Neighbor Standard Dev (m): 51.100
- Nearest Neigh Coeff of Variation (%): 113.371
- Mean Proximity Index: NA
- Shannon's Diversity Index: 1.651
- Simpson's Diversity Index: 0.786
- Modified Simpson's Diversity Index: 1.540
- Patch Richness: 7
- Patch Richness Density (/100 ha): 1.401
- Relative Patch Richness (%): NA
- Shannon's Evenness Index: 0.849
- Simpson's Evenness Index: 0.917
- Modified Simpson's Evenness Index: 0.791
- Interpersion/Juxtaposition Index (%): 68.366
- Contagion (%): "1"
60ha

Processing image: 60ha.gis
Number of rows, cols: 59, 82
Interior Background Value: 0
Exterior Background Value: 0
Reading 8 bit ERDAS image ...

... 3233 cells of background exterior to the landscape found ...
120ha
catProcessing image: 120ha.gis
Number of rows, cols: 88, 120
Interior Background Value: 0
Exterior Background Value: 0
Reading 8 bit ERDAS image...

... 7543 cells of background exterior to the landscape found

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<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
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<td>811</td>
<td>342</td>
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<tr>
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<td>47</td>
<td>104</td>
<td>43</td>
<td>29</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

number of classes: 6
max patches/class: 104
max_patch_size: 7342 (background/border patch)

LANDSCAPE INDICES
Total Area (ha): 120.680
Largest Patch Index (%): 7.458
Number of patches: 339
Patch Density (#/100 ha): 280.908
Mean Patch Size (ha): 0.356
Patch Size Standard Dev (ha): 0.879
Patch Size Coef of Variation (%): 244.578
Total Edge (m): 66660.000
Edge Density (m/ha): 568.943
Contrast-Weight Edge Density (m/ha): NA
Total Edge Contrast Index (%): NA
Mean Edge Contrast Index (%): NA
Area-Weighted Mean Edge Contrast (%): NA

Landscape Shape Index: 15.625
mean Shape Index: 1.248
Area-Weighted Mean Shape Index: 2.143
Double Log Fractal Dimension: 1.407
Mean Patch Fractal Dimension: 1.042
Area-Weighted Mean Fractal Dimension: 1.134
Total Core Area (ha): 22.800
Number of Core Areas: 82
Core Area Density (#/100 ha): 67.948
Mean Core Area 1 (ha): 0.067
Core Area Standard Dev 1 (ha): 0.286
Core Area Coef of Variation 1 (%): 425.358
Mean Core Area 2 (ha): 0.278
Core Area Standard Dev 2 (ha): 0.523
Core Area Coef of Variation 2 (%): 785.715
Total Core Area Index (%): 18.891
Mean Core Area Index (%): 2.828

Mean Nearest Neighbor (m): 67.274
Nearest Neighbor Standard Dev (m): 65.161
Nearest Neigh Coeff of Variation (%): 126.386
Mean Proximity Index: NA
Shannon's Diversity Index: 1.579
Simpson's Diversity Index: 0.764
modified Simpson's Diversity Index: 1.442
Patch Richness: 6
Patch Richness Density (#/100 ha): 4.972
Relative Patch Richness (%): NA
Shannon's Evenness Index: 0.881
Simpson's Evenness Index: 0.916
modified Simpson's Evenness Index: 0.805
Interspersion/Juxtaposition Index (%): 71.741
Concentration (%): 31.485
Processing image: 238ha.gis
Number of rows, cols: 12, 159
Interior Background Value: 0
Exterior Background Value: 0
Reading 8 bit ERDAS image . . .

... 11778 cells of background exterior to the landscape found

<table>
<thead>
<tr>
<th>Class</th>
<th>1:</th>
<th>992 cells, 86 patches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
<td>2:</td>
<td>2010 cells, 76 patches</td>
</tr>
<tr>
<td>Class</td>
<td>3:</td>
<td>273 cells, 151 patches</td>
</tr>
<tr>
<td>Class</td>
<td>4:</td>
<td>1885 cells, 74 patches</td>
</tr>
<tr>
<td>Class</td>
<td>5:</td>
<td>639 cells, 49 patches</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LANDSCAPE INDICES</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Area (ha)</td>
<td>241.200</td>
</tr>
<tr>
<td>Largest Pitch Index (%)</td>
<td>9.436</td>
</tr>
<tr>
<td>Number of patches</td>
<td>511</td>
</tr>
<tr>
<td>Patch Density (#/100 ha)</td>
<td>211.857</td>
</tr>
<tr>
<td>Mean Patch Size (ha)</td>
<td>0.472</td>
</tr>
<tr>
<td>Patch Size Standard Dev (ha)</td>
<td>1.559</td>
</tr>
<tr>
<td>Patch Size Coeff of Variation (%)</td>
<td>330.190</td>
</tr>
<tr>
<td>Total Edge (a)</td>
<td>114840.000</td>
</tr>
<tr>
<td>Edge Density (a/ha)</td>
<td>476.119</td>
</tr>
<tr>
<td>Contrast-Weight Edge Density (a/ha)</td>
<td>NA</td>
</tr>
<tr>
<td>Total Edge Contrast Index (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Mean Edge Contrast Index (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Area-Weighted Mean Edge Contrast (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Landscape Shape Index</td>
<td>18.486</td>
</tr>
<tr>
<td>Mean Shape Index</td>
<td>1.258</td>
</tr>
<tr>
<td>Area-Weighted Mean Shape Index</td>
<td>2.313</td>
</tr>
<tr>
<td>Double Log Fractal Dimension</td>
<td>1.405</td>
</tr>
<tr>
<td>Mean Patch Fractal Dimension</td>
<td>1.043</td>
</tr>
<tr>
<td>Area-Weighted Mean Fractal Dimension</td>
<td>1.144</td>
</tr>
<tr>
<td>Total Core Area (ha)</td>
<td>69.680</td>
</tr>
<tr>
<td>Number of Core Areas</td>
<td>135</td>
</tr>
<tr>
<td>Core Area Density (#/100 ha)</td>
<td>55.970</td>
</tr>
<tr>
<td>Mean Core Area 1 (ha)</td>
<td>0.136</td>
</tr>
<tr>
<td>Core Area Standard Dev 1 (ha)</td>
<td>0.860</td>
</tr>
<tr>
<td>Core Area Coeff of Variation 1 (%)</td>
<td>63.270</td>
</tr>
<tr>
<td>Mean Core Area 2 (ha)</td>
<td>0.516</td>
</tr>
<tr>
<td>Core Area Standard Dev 2 (ha)</td>
<td>1.613</td>
</tr>
<tr>
<td>Core Area Coeff of Variation 2 (%)</td>
<td>1182.659</td>
</tr>
<tr>
<td>Total Core Area Index (%)</td>
<td>28.889</td>
</tr>
<tr>
<td>Mean Core Area Index (%)</td>
<td>3.193</td>
</tr>
<tr>
<td>Mean Nearest Neighbor (a)</td>
<td>64.904</td>
</tr>
<tr>
<td>Nearest Neighbor Standard Dev (a)</td>
<td>77.654</td>
</tr>
<tr>
<td>Nearest Neighbor Coeff of Variation (%)</td>
<td>119.643</td>
</tr>
<tr>
<td>Mean Proximity Index</td>
<td>NA</td>
</tr>
<tr>
<td>Shannon's Diversity Index</td>
<td>1.527</td>
</tr>
<tr>
<td>Simpson's Diversity Index</td>
<td>0.749</td>
</tr>
<tr>
<td>Modified Simpson's Diversity Index</td>
<td>1.381</td>
</tr>
<tr>
<td>Patch Richness</td>
<td>5</td>
</tr>
<tr>
<td>Patch Richness Density (#/100 ha)</td>
<td>2.488</td>
</tr>
<tr>
<td>Relative Patch Richness (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Shannon's Evenness Index</td>
<td>0.852</td>
</tr>
<tr>
<td>Simpson's Evenness Index</td>
<td>0.998</td>
</tr>
<tr>
<td>Modified Simpson's Evenness Index</td>
<td>0.771</td>
</tr>
<tr>
<td>Interspersion/Justaposition Index (%)</td>
<td>76.110</td>
</tr>
</tbody>
</table>
475ha

Processing image: 475ha.gis
Number of rows, cols: 151, 202
Interior Background Value: 0
Exterior Background Value: 0
Reading 8 bit ERDAS image ...

... 18525 cells of background exterior to the landscape found

<table>
<thead>
<tr>
<th>Class</th>
<th>1st cell</th>
<th>2nd cell</th>
<th>3rd cell</th>
<th>4th cell</th>
<th>5th cell</th>
<th>6th cell</th>
<th>7th cell</th>
<th>8th cell</th>
<th>9th cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>2159 cells, 120 patches</td>
<td>2715 cells, 111 patches</td>
<td>428 cells, 138 patches</td>
<td>4217 cells, 225 patches</td>
<td>2137 cells, 127 patches</td>
<td>321 cells, 75 patches</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**LANDSCAPE INDICES**

- **Total Area (ha):** 479.080
- **Largest Patch Index (%):** 10.453
- **Number of patches:** 976
- **Patch Density (#/100 ha):** 166.152
- **Mean Patch Size (ha):** 0.602
- **Patch Size Standard Dev (ha):** 3.220
- **Patch Size Coef of Variation (%):** 535.014
- **Total Edge (#):** 1999.000
- **Edge Density (m/ha):** 417.383
- **Contrast-Weight Edge Density (m/ha):** NA
- **Total Edge Contrast Index (%):** NA
- **Mean Edge Contrast Index (%):** NA
- **Area-Weighted Mean Edge Contrast (%):** NA
- **Landscape Shape Index:** 22.839
- **Mean Shape Index:** 1.261
- **Area-Weighted Mean Shape Index:** 3.240
- **Double Log Fractal Dimension:** 1.420
- **Mean Patch Fractal Dimension:** 1.043
- **Area-Weighted Mean Fractal Dimension:** 1.138
- **Total Core Area (ha):** 147.840
- **Number of Core Areas:** 213
- **Core Area Density (#/100 ha):** 44.460
- **Mean Core Area (ha):** 0.211
- **Core Area Standard Dev 1 (ha):** 1.788
- **Core Area Coef of Variation 1 (%):** 947.978
- **Mean Core Area 2 (ha):** 3.788
- **Core Area Standard Dev 2 (ha):** 3.390
- **Core Area Coef of Variation 2 (%):** 147.772
- **Total Core Area Index (%):** 35.524
- **Mean Core Area Index (%):** 2.837
- **Mean Nearest Neighbor (#):** 61.870
- **Nearest Neighbor Standard Dev (#):** 73.544
- **Nearest Neighbor Coef of Variation (%):** 148.869
- **Mean Proximity Index:** NA

**Shannon's Diversity Index:** 1.536
**Simpson's Diversity Index:** 0.758
**Modified Simpson's Diversity Index:** 1.420
**Patch Richness:** 6
**Patch Richness Density (#/100 ha):** 1.252
**Relative Patch Richness (%):** NA
**Shannon's Evenness Index:** 0.857
**Simpson's Evenness Index:** 0.910
**Modified Simpson's Evenness Index:** 0.793
**Interspersion/Juxtaposition Index (%):** 75.103
**Continuity (%):** 37.863
... 30540 cells of background exterior to the landscape found

<table>
<thead>
<tr>
<th>Class</th>
<th>Cells</th>
<th>Patches</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5176</td>
<td>180</td>
</tr>
<tr>
<td>2</td>
<td>3051</td>
<td>169</td>
</tr>
<tr>
<td>3</td>
<td>915</td>
<td>280</td>
</tr>
<tr>
<td>4</td>
<td>9188</td>
<td>379</td>
</tr>
<tr>
<td>5</td>
<td>5773</td>
<td>250</td>
</tr>
<tr>
<td>6</td>
<td>567</td>
<td>145</td>
</tr>
</tbody>
</table>

**LANDSCAPE INDICES**

- Total Area (ha): 946.800
- Largest Patch Index (t): 11.914
- Number of patches: 1403
- Patch Density (#/100 ha): 148.183
- Mean Patch Size (ha): 0.675
- Patch Size Standard Dev (ha): 4.899
- Patch Size Coeff of Variation (%): 72.065
- Total Edge (m): 389980.000
- Edge Density (m/ha): 411.993
- Contrast-Weighted Edge Density (m/ha): NA
- Total Edge Contrast Index (t): NA
- Mean Edge Contrast Index (%): NA
- Area-Weighted Mean Edge Contrast Index: NA
- Landscape Shape Index: 31.885
- Mean Shape Index: 1.294
- Area-Weighted Mean Shape Index: 4.253
- Double Log Fractal Dimension: 1.430
- Mean Patch Fractal Dimension: 1.043
- Area-Weighted Mean Fractal Dimension: 1.207
- Total Core Area (ha): 340.280
- Number of Core Areas: 420
- Core Area Density (#/100 ha): 44.386
- Mean Core Area (ha): 0.243
- Core Area Standard Dev (ha): 2.706
- Core Area Coeff of Variation 1 (%): 115.507
- Mean Core Area 2 (ha): 0.810
- Core Area Standard Dev 2 (ha): 4.898
- Core Area Coeff of Variation 2 (%): 2019.545
- Total Core Area Index (t): 35.940
- Mean Core Area Index (%): 2.638
- Mean Nearest Neighbor (m): 59.025
- Nearest Neighbor Standard Dev (m): 72.444
- Nearest Neigh Coeff of Variation (%): 122.574
- Mean Proximity Index: NA
- Shannon's Diversity Index: 1.523
- Simpson's Diversity Index: 0.754
- Modified Simpson's Diversity Index: 1.404
- Patch Richness: NA
- Patch Richness Density (#/100 ha): 0.634
- Relative Patch Richness (%): NA
- Shannon's Evenness Index: 0.850
- Simpson's Evenness Index: 0.705
- Modified Simpson's Evenness Index: 0.784
- Interspersion/Justuxtaposition Index (t): 73.013
- Cost (t): 39.904
Processing image: 1900ha.gis
Number of rows, cols: 251, 426

Interior Background Value: 0
Exterior Background Value: 0
Reading 8 bit ERDAS image ....

... 58383 cells of background exterior to the landscape found

<table>
<thead>
<tr>
<th>Class</th>
<th>Interior Cells</th>
<th>Exterior Cells</th>
<th>Patches</th>
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<tbody>
<tr>
<td>1</td>
<td>9160</td>
<td>352</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>4377</td>
<td>261</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2819</td>
<td>617</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>17034</td>
<td>726</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>13606</td>
<td>465</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>1500</td>
<td>260</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>47</td>
<td>14</td>
<td></td>
</tr>
</tbody>
</table>

Number of classes: 7
max patches/class: 726
max patch size: 45831 (background/border patch)

**LANDSCAPE INDICES**

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Area (ha)</td>
<td>1914.720</td>
</tr>
<tr>
<td>Largest Patch Index (%)</td>
<td>11.083</td>
</tr>
<tr>
<td>Number of patches</td>
<td>2695</td>
</tr>
<tr>
<td>Patch Density (#/100 ha)</td>
<td>138.794</td>
</tr>
<tr>
<td>Mean Patch Size (ha)</td>
<td>0.720</td>
</tr>
<tr>
<td>Patch Size Standard Dev (ha)</td>
<td>5.683</td>
</tr>
<tr>
<td>Patch Size Coeff of Variation (%)</td>
<td>816.540</td>
</tr>
<tr>
<td>Total Edge (m)</td>
<td>791340.000</td>
</tr>
<tr>
<td>Edge Density (w/ha)</td>
<td>407.546</td>
</tr>
<tr>
<td>Contrast-Weight Edge Density (w/ha)</td>
<td>NA</td>
</tr>
<tr>
<td>Total Edge Contrast Index (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Mean Edge Contrast Index (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Area Weighted Mean Edge Contrast (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Landscape Shape Index</td>
<td>44.994</td>
</tr>
<tr>
<td>Mean Shape Index</td>
<td>1.291</td>
</tr>
<tr>
<td>Area Weighted Mean Shape Index</td>
<td>4.552</td>
</tr>
<tr>
<td>Double Log Fractal Dimension</td>
<td>1.437</td>
</tr>
<tr>
<td>Mean Patch Fractal Dimension</td>
<td>1.046</td>
</tr>
<tr>
<td>Area Weighted Mean Fractal Dimension</td>
<td>1.206</td>
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<tr>
<td>Total Core Area (ha)</td>
<td>700.310</td>
</tr>
<tr>
<td>Number of Core Areas</td>
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</tr>
<tr>
<td>Core Area Density (#/100 ha)</td>
<td>43.930</td>
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<tr>
<td>Mean Core Area 1 (ha)</td>
<td>0.260</td>
</tr>
<tr>
<td>Core Area Standard Dev 1 (ha)</td>
<td>3.309</td>
</tr>
<tr>
<td>Core Area Coeff of Variation 1 (%)</td>
<td>1272.500</td>
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<tr>
<td>Mean Core Area 2 (ha)</td>
<td>0.821</td>
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<tr>
<td>Core Area Standard Dev 2 (ha)</td>
<td>5.843</td>
</tr>
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<td>Core Area Coeff of Variation 2 (%)</td>
<td>2248.561</td>
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<tr>
<td>Total Core Area Index (%)</td>
<td>35.047</td>
</tr>
<tr>
<td>Mean Core Area Index (%)</td>
<td>2.823</td>
</tr>
<tr>
<td>Mean Nearest Neighbor (m)</td>
<td>50.048</td>
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<tr>
<td>Nearest Neighbor Standard Dev (m)</td>
<td>81.133</td>
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<tr>
<td>Nearest Neigh Coeff of Variation (%)</td>
<td>129.770</td>
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<td>NA</td>
</tr>
<tr>
<td>Shannon's Diversity Index</td>
<td>1.525</td>
</tr>
<tr>
<td>Simpson's Diversity Index</td>
<td>0.750</td>
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<td>Modified Simpson's Diversity Index</td>
<td>1.387</td>
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<tr>
<td>Patch Richness</td>
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<td>Patch Richness Density (#/100 ha)</td>
<td>0.361</td>
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<tr>
<td>Relative Patch Richness (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Shannon's Evenness Index</td>
<td>0.789</td>
</tr>
<tr>
<td>Simpson's Evenness Index</td>
<td>0.875</td>
</tr>
<tr>
<td>Modified Simpson's Evenness Index</td>
<td>0.713</td>
</tr>
<tr>
<td>Interspersed/Interposition Index (%)</td>
<td>64.244</td>
</tr>
<tr>
<td>Contig (m)</td>
<td>44.547</td>
</tr>
</tbody>
</table>
In the landscape found, 456351 cells of background exterior were processed.

### Landscape Indices

<table>
<thead>
<tr>
<th>Class</th>
<th>Cells</th>
<th>Patches</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>19146</td>
<td>894</td>
</tr>
<tr>
<td>2</td>
<td>7581</td>
<td>463</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>10082</td>
<td>1289</td>
</tr>
<tr>
<td>5</td>
<td>29349</td>
<td>1496</td>
</tr>
<tr>
<td>6</td>
<td>24928</td>
<td>809</td>
</tr>
<tr>
<td>7</td>
<td>102</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>3228</td>
<td>453</td>
</tr>
<tr>
<td>9</td>
<td>852</td>
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<tr>
<td>10</td>
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<td>11</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>12</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

#### Class 1
- Cells: 19146
- Patches: 894

#### Class 2
- Cells: 7581
- Patches: 463

#### Class 3
- Cells: 5
- Patches: 2

#### Class 4
- Cells: 10082
- Patches: 1289

#### Class 5
- Cells: 29349
- Patches: 1496

#### Class 6
- Cells: 24928
- Patches: 809

#### Class 7
- Cells: 102
- Patches: 1

#### Class 8
- Cells: 3228
- Patches: 453

#### Class 9
- Cells: 852
- Patches: 115

#### Class 10
- Cells: 6
- Patches: 1

#### Class 11
- Cells: 1
- Patches: 1

#### Class 12
- Cells: 1
- Patches: 1

### Total Area (ha): 3808.000
### Largest Patch Index (%): 5.894
### Number of patches: 5544
### Patch Density (#/100 ha): 145.580
### Mean Patch Size (ha): 0.687
### Patch Size Standard Dev (ha): 4.689
### Patch Size Coefficient of Variation (%): 682.451
### Total Edge (m): 1600850.000
### Edge Density (m/ha): 422.290
### Contrast-Weight Edge Density (m/ha): NA
### Total Edge Contrast Index (%): NA
### Mean Edge Contrast Index (%): NA
### Area-Weighted Mean Edge Contrast (%): NA
### Landscape Shape Index: 65.148
### Mean Shape Index: 1.305
### Area-Weighted Mean Shape Index: 3.900
### Double Log Fractal Dimension: 1.433
### Mean Patch Fractal Dimension: 1.049
### Area-Weighted Mean Fractal Dimension: 1.191

### Total Core Area (ha): 1294.960
### Number of Core Areas: 1789
### Core Area Density (#/100 ha): 46.980
### Mean Core Area (ha): 0.234
### Core Area Standard Dev 1 (ha): 2.586
### Core Area Coefficient of Variation 1 (%): 110.155
### Mean Core Area 2 (ha): 0.724
### Core Area Standard Dev 2 (ha): 4.513
### Core Area Coefficient of Variation 2 (%): 1932.255
### Total Core Area Index (%): 34.006
### Mean Core Area Index (%): 3.239
### Mean Nearest Neighbor (m): 58.132
### Nearest Neighbor Standard Dev (m): 85.090
### Nearest Neighbor Coefficient of Variation (%): 146.373
### Mean Proximity Index: NA
### Shannon's Diversity Index: 1.634
### Simpson's Diversity Index: 0.777
### Modified Simpson's Diversity Index: 1.501
### Patch Richness: 11
### Patch Richness Density (#/100 ha): 0.289
### Relative Patch Richness (%): 91.667
### Shannon's Evenness Index: 0.681
### Simpson's Evenness Index: 0.855
### Modified Simpson's Evenness Index: 0.626
### Interspersion/Juxtaposition Index (%): 50.258
### Contagion (%): 51.727
... 621 cells of background exterior to the landscape found

<table>
<thead>
<tr>
<th>Class</th>
<th>1</th>
<th>430 cells, 19 patches</th>
<th>2</th>
<th>264 cells, 36 patches</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
<td>126 cells, 13 patches</td>
<td>4</td>
<td>32 cells, 12 patches</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>35 cells, 19 patches</td>
<td>6</td>
<td>174 cells, 17 patches</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>106 cells, 13 patches</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Class | 9 | 201 cells, 24 patches |

Number of classes: 6
max patches/class: 36
max patch size: 306

Verifying that background patches are classified accordingly

<table>
<thead>
<tr>
<th>LANDSCAPE INDICES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Area (ha): 59,520</td>
</tr>
<tr>
<td>Largest Patch Index (%): 20.565</td>
</tr>
<tr>
<td>Number of patches: 149</td>
</tr>
<tr>
<td>Patch Density (#/100 ha): 250.336</td>
</tr>
<tr>
<td>Mean Patch Size (ha): 0.399</td>
</tr>
<tr>
<td>Patch Size Standard Dev (ha): 1.106</td>
</tr>
<tr>
<td>Patch Size Coeff of Variation (%): 276.991</td>
</tr>
</tbody>
</table>
| Total Edge (m): nnnmn
| Edge Density (m/ha): 504.032        |
| Contrast-Weight Edge Density (m/ha): NA |
| Total Edge Contrast Index (°): NA    |
| Mean Edge Contrast Index (%): NA     |
| Area-Weighted Mean Edge Contrast (%): NA |
| Landscape Shape Index: 9.721         |
| Mean Shape Index: 1.312              |
| Area-Weighted Mean Shape Index: 2.540 |
| Double Log Fractal Dimension: 1.435  |
| Mean Patch Fractal Dimension: 1.054  |
| Area-Weighted Mean Fractal Dimension: 1.149 |
| Total Core Area (ha): 7.840         |
| Number of Core Areas: 45             |
| Core Area Density (#/100 ha): 75.605 |
| Mean Core Area 1 (ha): 0.053         |
| Core Area Standard Dev 1 (ha): 0.299 |
| Core Area Coeff of Variation 1 (%): 567.525 |
| Mean Core Area 2 (ha): 0.174         |
| Core Area Standard Dev 2 (ha): 0.524 |
| Core Area Coeff of Variation 2 (%): 994.955 |
| Total Core Area Index (%): 12.172    |
| Mean Core Area Index (%): 2.703      |
| Mean Nearest Neighbor (m): 42.136    |
| Nearest Neighbor Standard Dev (m): 36.033 |
| Nearest Neighbor Coeff of Variation (%): 85.516 |
| Mean Proximity Index: NA             |
| Shannon's Diversity Index: 1.709     |
| Simpson's Diversity Index: 0.865     |
| Modified Simpson's Diversity Index: 1.636 |
| Patch Richness:                      |
| Patch Richness Density (#/100 ha): 10.061 |
| Relative Patch Richness (%): NA      |
| Shannon's Evenness Index: 0.954      |
| Simpson's Evenness Index: 0.966      |
| Modified Simpson's Evenness Index: 0.913 |
| Interspersion/Juxtaposition Index (%): 87.726 |
| Contagion (°): 20.99                 |

Processing image: 59eha.gis
Number of rows, cols: 17, 57
Interior Background Value: 0
Exterior Background Value: 0
Reading 8 bit ERDAS image...
... 1280 cells of background exterior to the landscape found

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<th>Number of cells</th>
<th>Number of patches</th>
<th>Patch Density ($/100 ha$)</th>
<th>Mean Patch Size (ha)</th>
<th>Patch Size Standard Dev (ha)</th>
<th>Patch Size Coef of Variation (%)</th>
<th>Total Edge (m)</th>
<th>Edge Density (m/ha)</th>
<th>Contrast-Weight Edge Density (m/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>592 cells</td>
<td>41 patches</td>
<td>2,280</td>
<td>0.437</td>
<td>1.286</td>
<td>9.235</td>
<td>54060.000</td>
<td>471.792</td>
<td>NA</td>
</tr>
<tr>
<td>2</td>
<td>597 cells</td>
<td>55 patches</td>
<td>228.758</td>
<td>0.048</td>
<td>1.988</td>
<td>294.235</td>
<td>54060.000</td>
<td>471.792</td>
<td>NA</td>
</tr>
<tr>
<td>3</td>
<td>242 cells</td>
<td>44 patches</td>
<td>2,280</td>
<td>0.437</td>
<td>1.286</td>
<td>9.235</td>
<td>54060.000</td>
<td>471.792</td>
<td>NA</td>
</tr>
<tr>
<td>4</td>
<td>683 cells</td>
<td>59 patches</td>
<td>228.758</td>
<td>0.048</td>
<td>1.988</td>
<td>294.235</td>
<td>54060.000</td>
<td>471.792</td>
<td>NA</td>
</tr>
<tr>
<td>5</td>
<td>290 cells</td>
<td>33 patches</td>
<td>2,280</td>
<td>0.437</td>
<td>1.286</td>
<td>9.235</td>
<td>54060.000</td>
<td>471.792</td>
<td>NA</td>
</tr>
<tr>
<td>6</td>
<td>495 cells</td>
<td>34 patches</td>
<td>2,280</td>
<td>0.437</td>
<td>1.286</td>
<td>9.235</td>
<td>54060.000</td>
<td>471.792</td>
<td>NA</td>
</tr>
</tbody>
</table>

**LANDSCAPE INDICES**

- Total Area (ha): 116.280
- Largest Patch Index (%): 11.008
- Number of patches: 264
- Patch Density ($/100 ha$): 228.758
- Mean Patch Size (ha): 0.437
- Patch Size Standard Dev (ha): 1.286
- Patch Size Coef of Variation (%): 9.235
- Total Edge (m): 54060.000
- Edge Density (m/ha): 471.792
- Contrast-Weight Edge Density (m/ha): NA
- Total Edge Contrast Index (%): NA
- Mean Edge Contrast Index (%): NA
- Area-Weighted Mean Edge Contrast (%): NA
- Landscape Shape Index: 12.719
- Mean Shape Index: 1.302
- Area-Weighted Mean Shape Index: 2.509
- Double Log Fractal Dimension: 1.456
- Mean Patch Fractal Dimension: 1.051
- Area-Weighted Mean Fractal Dimension: 1.148
- Total Core Area (ha): 21.320
- Number of Core Areas: 80
- Core Area Density ($/100 ha$): 68.7999
- Mean Core Area 1 (ha): 0.080
- Core Area Standard Dev 1 (ha): 0.457
- Core Area Coef of Variation 1 (%): 57.0113
- Mean Core Area 2 (ha): 0.266
- Core Area Standard Dev 2 (ha): 0.803
- Core Area Coef of Variation 2 (%): 1001.516
- Total Core Area Index (%): 18.355
- Mean Core Area Index (%): 2.799
- Mean Nearest Neighbor (m): 49.590
- Nearest Neighbor Standard Dev (m): 47.443
- Nearest Neighbor Coef of Variation (%): 95.095
- Mean Proximity Index: NA
- Shannon's Diversity Index: 1.721
- Simpson's Diversity Index: 0.815
- Modified Simpson's Diversity Index: 1.688
- Patch Richness: 6
- Patch Richness Density ($/100 ha$): 5.186
- Relative Patch Richness (%): NA
- Shannon's Evenness Index: 0.966
- Simpson's Evenness Index: 0.978
- Modified Simpson's Evenness Index: 0.984
- Interspersion/Interposition Index (%): 90.507
- Contagion (%): 21.458
... 2789 cells of background exterior to the landscape found

<table>
<thead>
<tr>
<th>Class</th>
<th>Cells</th>
<th>Patches</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>993</td>
<td>82</td>
</tr>
<tr>
<td>2</td>
<td>1564</td>
<td>109</td>
</tr>
<tr>
<td>4</td>
<td>502</td>
<td>91</td>
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<tr>
<td>5</td>
<td>1708</td>
<td>133</td>
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<tr>
<td>6</td>
<td>738</td>
<td>71</td>
</tr>
<tr>
<td>9</td>
<td>631</td>
<td>67</td>
</tr>
</tbody>
</table>

Number of classes: 6
Max patches/class: 133

**Landscape Indices**

- **Total Area (ha):** 245.520
- **Largest Patch Index (t):** 8.179
- **Number of patches:** 552
- **Patch Density (#/100 ha):** 225.236
- **Mean Patch Size (ha):** 0.444
- **Patch Size Standard Dev (ha):** 1.258
- **Patch Size Coeff of Variation (%):** 31.999
- **Total Edge (m):** 114220.000
- **Edge Density (m/ha):** 445.217
- **Contrast-Weight Edge Density (m/ha):** NA
- **Total Edge Contrast Index (t):** NA
- **Mean Edge Contrast Index (t):** NA
- **Area Weighted Mean Edge Contrast (t):** NA
- **Landscape Shape Index:** 18.224
- **Mean Shape Index:** 1.313
- **Area Weighted Mean Shape Index:** 2.430
- **Double Log Fractal Dimension:** 1.452
- **Mean Patch Fractal Dimension:** 1.054
- **Area Weighted Mean Fractal Dimension:** 1.146
- **Total Core Area (ha):** 46.760
- **Number of Core Areas:** 166
- **Core Area Density (#/100 ha):** 67.612
- **Mean Core Area 1 (ha):** 0.085
- **Core Area Standard Dev 1 (ha):** 0.629
- **Core Area Coeff of Variation 1 (t):** 744.319
- **Mean Core Area 2 (ha):** 0.282
- **Core Area Standard Dev 2 (ha):** 1.154
- **Core Area Coeff of Variation 2 (t):** 1329.634
- **Total Core Area Index (t):** 19.045
- **Mean Core Area Index (t):** 3.867
- **Mean Nearest Neighbor (m):** 47.328
- **Nearest Neighbor Standard Dev (m):** 42.136
- **Nearest Neighbor Coeff of Variation (t):** 98.099
- **Mean Proximity Index:** NA
- **Shannon's Diversity Index:** 1.692
- **Simpson's Diversity Index:** 0.800
- **Modified Simpson's Diversity Index:** 1.667
- **Patch Richness:** 6
- **Patch Richness Density (#/100 ha):** 2.444
- **Relative Patch Richness (t):** NA
- **Shannon's Evenness Index:** 0.945
- **Simpson's Evenness Index:** 0.960
- **Modified Simpson's Evenness Index:** 0.997
- **Shannon's Evenness Index:** 0.945
- **Simpson's Evenness Index:** 0.960
- **Modified Simpson's Evenness Index:** 0.997

**Interpretation:**
475seha

Processing image: 475seha.gis
Number of rows, cols: 111, 161
Interior Background Value: 0
Exterior Background Value: 0
Reading 8 bit ERDAS image ....

... 6073 cells of background exterior to the landscape found

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<th>Cells</th>
<th>Patches</th>
</tr>
</thead>
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</tr>
<tr>
<td>2</td>
<td>2732</td>
<td>166</td>
</tr>
<tr>
<td>3</td>
<td>1099</td>
<td>161</td>
</tr>
<tr>
<td>4</td>
<td>3726</td>
<td>217</td>
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<tr>
<td>5</td>
<td>1558</td>
<td>136</td>
</tr>
<tr>
<td>6</td>
<td>818</td>
<td>113</td>
</tr>
</tbody>
</table>

number of classes: 6
max patches/class: 217
max_patch_size: 1441 (background/border patch)

**LANDSCAPE INDICES**

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Total Area (ha)</td>
<td>471.920</td>
</tr>
<tr>
<td>Largest Patch Index (1)</td>
<td>8.154</td>
</tr>
<tr>
<td>Number of patches</td>
<td>926</td>
</tr>
<tr>
<td>Patch Density (#/100 ha)</td>
<td>194.220</td>
</tr>
<tr>
<td>Mean Patch Size (ha)</td>
<td>0.510</td>
</tr>
<tr>
<td>Patch Size Standard Dev (ha)</td>
<td>1.830</td>
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<tr>
<td>Patch Size Coef of Variation (t)</td>
<td>359.149</td>
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<tr>
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<td>Edge Density (m/ha)</td>
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<tr>
<td>Contrast-Weight Edge Density (m/ha)</td>
<td>NA</td>
</tr>
<tr>
<td>Total Edge Contrast Index (t)</td>
<td>NA</td>
</tr>
<tr>
<td>Mean Edge Contrast Index (t)</td>
<td>NA</td>
</tr>
<tr>
<td>Landscape Shape Index</td>
<td>23.578</td>
</tr>
<tr>
<td>Mean Shape Index</td>
<td>1.226</td>
</tr>
<tr>
<td>Area-Weighted Mean Shape Index</td>
<td>2.622</td>
</tr>
<tr>
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<td>1.453</td>
</tr>
<tr>
<td>Mean Patch Fractal Dimension</td>
<td>1.054</td>
</tr>
<tr>
<td>Area-Weighted Mean Fractal Dimension</td>
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</tr>
<tr>
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<tr>
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</tr>
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</tr>
<tr>
<td>Mean Nearest Neighbor (m)</td>
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<tr>
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<tr>
<td>Shannon's Diversity Index</td>
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</tr>
<tr>
<td>Simpson's Diversity Index</td>
<td>0.791</td>
</tr>
<tr>
<td>Modified Simpson's Diversity Index</td>
<td>1.564</td>
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<tr>
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<tr>
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<tr>
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<tr>
<td>Simpson's Evenness Index</td>
<td>0.949</td>
</tr>
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<td>Modified Simpson's Evenness Index</td>
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</table>
... 16734 cells of background exterior to the landscape found

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<tr>
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<th>Number of patches</th>
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<tr>
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<tr>
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<td>3507</td>
<td>285</td>
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<tr>
<td>3</td>
<td>2386</td>
<td>320</td>
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<tr>
<td>4</td>
<td>8124</td>
<td>445</td>
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<tr>
<td>5</td>
<td>4536</td>
<td>292</td>
</tr>
<tr>
<td>6</td>
<td>1226</td>
<td>189</td>
</tr>
</tbody>
</table>

Number of classes: 6  
Max patches/class: 445  
Max patch size: 5123 (background/border patch)

Verifying that background patches are classified

<table>
<thead>
<tr>
<th>LANDSCAPE INDICES</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Area (ha)</td>
<td>953.880</td>
</tr>
<tr>
<td>Largest Patch Index (%)</td>
<td>5.221</td>
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<tr>
<td>Number of patches</td>
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</tr>
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</tr>
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</tr>
<tr>
<td>Patch Size Standard Dev (ha)</td>
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</tr>
<tr>
<td>Patch Size Coeff of Variation (%)</td>
<td>384.991</td>
</tr>
<tr>
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</tr>
<tr>
<td>Edge Density (m/ha)</td>
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</tr>
<tr>
<td>Contrast-weighted Edge Density (m/ha)</td>
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</tr>
<tr>
<td>Total Edge Contrast Index (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Mean Edge Contrast Index (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Area-weighted Mean Edge Contrast (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Landscape Shape Index</td>
<td>34.061</td>
</tr>
<tr>
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<tr>
<td>Area-weighted Mean Shape Index</td>
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<tr>
<td>Double Log Fractal Dimension</td>
<td>1.149</td>
</tr>
<tr>
<td>Mean Patch Fractal Dimension</td>
<td>1.051</td>
</tr>
<tr>
<td>Area-weighted Mean Fractal Dimension</td>
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</tr>
<tr>
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<tr>
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</tr>
<tr>
<td>Core Area Coefficient of Variation (%)</td>
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<tr>
<td>Core Area Standard Dev 2 (ha)</td>
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<td>Core Area Coefficient of Variation 2 (%)</td>
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<tr>
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<tr>
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<td>1.650</td>
</tr>
<tr>
<td>Simpson's Diversity Index</td>
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</tr>
<tr>
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</tr>
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</tr>
<tr>
<td>Patch Richness Density (#/100 ha)</td>
<td>0.629</td>
</tr>
<tr>
<td>Relative Patch Richness (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Shannon's Evenness Index</td>
<td>0.921</td>
</tr>
<tr>
<td>Simpson's Evenness Index</td>
<td>0.941</td>
</tr>
<tr>
<td>Modified Simpson's Evenness Index</td>
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</tr>
<tr>
<td>Interspersion/Intra-position Index (%)</td>
<td>94.213</td>
</tr>
<tr>
<td>Contagion (%)</td>
<td>27.146</td>
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Exterior Background Value: 0
Reading 0 bit ERDAS image ....

... 43322 cells of background exterior to the landscape found

<table>
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<tr>
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<th>1: 10364 cells, 634 patches</th>
<th>2: 4213 cells, 425 patches</th>
<th>4: 6190 cells, 775 patches</th>
<th>5: 16291 cells, 955 patches</th>
<th>6: 9456 cells, 701 patches</th>
<th>9: 2082 cells, 350 patches</th>
<th>10: 171 cells, 8 patches</th>
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</thead>
<tbody>
<tr>
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<td>max patches/class: 955</td>
<td>max_patch_size: 15974 (background/border patch)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

**LANDSCAPE INDICES**

<table>
<thead>
<tr>
<th>Index</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Area (ha):</td>
<td>1951.000</td>
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<tr>
<td>Largest Patch Index (%):</td>
<td>6.050</td>
</tr>
<tr>
<td>Number of patches:</td>
<td>3848</td>
</tr>
<tr>
<td>Patch Density (#/100 ha):</td>
<td>197.232</td>
</tr>
<tr>
<td>Mean Patch Size (ha):</td>
<td>0.507</td>
</tr>
<tr>
<td>Patch Size Standard Dev (ha):</td>
<td>2.518</td>
</tr>
<tr>
<td>Patch Size Coeff of Variation (%):</td>
<td>49.681</td>
</tr>
<tr>
<td>Total Edge (a):</td>
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<tr>
<td>Edge Density (w/ha):</td>
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</tr>
<tr>
<td>Contrast-Weight Edge Density (w/ha):</td>
<td>NA</td>
</tr>
<tr>
<td>Total Edge Contrast Index (%):</td>
<td>NA</td>
</tr>
<tr>
<td>Mean Edge Contrast Index (%):</td>
<td>NA</td>
</tr>
<tr>
<td>Area-Weighted Mean Edge Contrast (%):</td>
<td>NA</td>
</tr>
<tr>
<td>Landscape Shape Index:</td>
<td>50.793</td>
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<tr>
<td>Mean Shape Index:</td>
<td>1.302</td>
</tr>
<tr>
<td>Area-Weighted Mean Shape Index:</td>
<td>2.951</td>
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<tr>
<td>Double Log Fractal Dimension:</td>
<td>1.438</td>
</tr>
<tr>
<td>Mean Patch Fractal Dimension:</td>
<td>1.030</td>
</tr>
<tr>
<td>Area-Weighted Mean Fractal Dimension:</td>
<td>1.153</td>
</tr>
<tr>
<td>Total Core Area (ha):</td>
<td>451.240</td>
</tr>
<tr>
<td>Number of Core Areas:</td>
<td>1258</td>
</tr>
<tr>
<td>Core Area Density (#/100 ha):</td>
<td>64.480</td>
</tr>
<tr>
<td>Mean Core Area 1 (ha):</td>
<td>0.117</td>
</tr>
<tr>
<td>Core Area Standard Dev 1 (ha):</td>
<td>1.322</td>
</tr>
<tr>
<td>Core Area Coef of Variation 1 (%):</td>
<td>112.245</td>
</tr>
<tr>
<td>Mean Core Area 2 (ha):</td>
<td>0.259</td>
</tr>
<tr>
<td>Core Area Standard Dev 2 (ha):</td>
<td>2.291</td>
</tr>
<tr>
<td>Core Area Coef of Variation 2 (%):</td>
<td>1953.694</td>
</tr>
<tr>
<td>Total Core Area Index (%):</td>
<td>23.125</td>
</tr>
<tr>
<td>Mean Core Area Index (%):</td>
<td>3.191</td>
</tr>
<tr>
<td>Mean Nearest Neighbor (a):</td>
<td>48.799</td>
</tr>
<tr>
<td>Nearest Neighbor Standard Dev (a):</td>
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</tr>
<tr>
<td>Nearest Neighbor Coef of Variation (%):</td>
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</tr>
<tr>
<td>Mean Proximity Index:</td>
<td>NA</td>
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<tr>
<td>Shannon's Diversity Index:</td>
<td>1.642</td>
</tr>
<tr>
<td>Simpson's Diversity Index:</td>
<td>1.790</td>
</tr>
<tr>
<td>Modified Simpson's Diversity Index:</td>
<td>1.515</td>
</tr>
<tr>
<td>Patch Richness:</td>
<td>7</td>
</tr>
<tr>
<td>Patch Richness Density (#/100 ha):</td>
<td>0.359</td>
</tr>
<tr>
<td>Relative Patch Richness [%]:</td>
<td>NA</td>
</tr>
<tr>
<td>Shannon's Evenness Index:</td>
<td>0.844</td>
</tr>
<tr>
<td>Simpson's Evenness Index:</td>
<td>0.910</td>
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<tr>
<td>Modified Simpson's Evenness Index:</td>
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<tr>
<td>Dispersion/Interposition Index (%):</td>
<td>12.950</td>
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<td>Contagion (%):</td>
<td>34.345</td>
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... 82142 cells of background exterior to the landscape found

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<thead>
<tr>
<th>Class</th>
<th>Cells</th>
<th>Patches</th>
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<td>2</td>
<td>5569</td>
<td>607</td>
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<tr>
<td>3</td>
<td>15720</td>
<td>1494</td>
</tr>
<tr>
<td>4</td>
<td>26904</td>
<td>1724</td>
</tr>
<tr>
<td>5</td>
<td>17447</td>
<td>1223</td>
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<td>6</td>
<td>4440</td>
<td>594</td>
</tr>
<tr>
<td>7</td>
<td>2613</td>
<td>62</td>
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</tbody>
</table>

**Landscape Indices**

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Area (ha)</td>
<td>3830.440</td>
</tr>
<tr>
<td>Largest Patch Index (%)</td>
<td>131.403</td>
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<td>Number of patches</td>
<td>6945</td>
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<tr>
<td>Patch Density (#/100 ha)</td>
<td>181.311</td>
</tr>
<tr>
<td>Mean Patch Size (ha)</td>
<td>0.552</td>
</tr>
<tr>
<td>Patch Size Standard Dev (ha)</td>
<td>2.506</td>
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<tr>
<td>Patch Size Coeff of Variation (%)</td>
<td>454.869</td>
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<tr>
<td>Total Edge (m)</td>
<td>1692940.000</td>
</tr>
<tr>
<td>Edge Density (m/ha)</td>
<td>441.970</td>
</tr>
<tr>
<td>Contrast-Weight Edge Density (m/ha)</td>
<td>NA</td>
</tr>
<tr>
<td>Total Edge Contrast Index (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Mean Edge Contrast Index (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Area-Weighted Mean Edge Contrast (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Landscape Shape Index</td>
<td>68.284</td>
</tr>
<tr>
<td>Mean Shape Index</td>
<td>1.315</td>
</tr>
<tr>
<td>Area-Weighted Mean Shape Index</td>
<td>3.029</td>
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<tr>
<td>Double Log Fractal Dimension</td>
<td>1.145</td>
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<tr>
<td>Mean Patch Fractal Dimension</td>
<td>1.051</td>
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<tr>
<td>Area-Weighted Mean Fractal Dimension</td>
<td>1.169</td>
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<tr>
<td>Total Core Area (ha)</td>
<td>925.560</td>
</tr>
<tr>
<td>Number of Core Areas</td>
<td>2437</td>
</tr>
<tr>
<td>Core Area Density (#/100 ha)</td>
<td>63.622</td>
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<tr>
<td>Mean Core Area 1 (ha)</td>
<td>0.133</td>
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<tr>
<td>Core Area Standard Dev 1 (ha)</td>
<td>0.249</td>
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<tr>
<td>Core Area Coeff of Variation 1 (%)</td>
<td>92.708</td>
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<tr>
<td>Mean Core Area 2 (ha)</td>
<td>0.280</td>
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<tr>
<td>Core Area Standard Dev 2 (ha)</td>
<td>0.286</td>
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<tr>
<td>Core Area Coeff of Variation 2 (%)</td>
<td>1165.177</td>
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<tr>
<td>Total Core Area Index (%)</td>
<td>24.143</td>
</tr>
<tr>
<td>Mean Core Area Index (%)</td>
<td>3.305</td>
</tr>
<tr>
<td>Mean Nearest Neighbor (m)</td>
<td>47.955</td>
</tr>
<tr>
<td>Nearest Neigh Coef Standard Dev (m)</td>
<td>72.749</td>
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<tr>
<td>Nearest Neigh Coef of Variation (%)</td>
<td>151.702</td>
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<tr>
<td>Mean Proximity Index</td>
<td>NA</td>
</tr>
<tr>
<td>Shannon's Diversity Index</td>
<td>1.713</td>
</tr>
<tr>
<td>Simpson's Diversity Index</td>
<td>0.767</td>
</tr>
<tr>
<td>Modified Simpson's Diversity Index</td>
<td>0.942</td>
</tr>
<tr>
<td>Patch Richness</td>
<td>7</td>
</tr>
<tr>
<td>Patch Richness Density (#/100 ha)</td>
<td>0.183</td>
</tr>
<tr>
<td>Relative Patch Richness (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Shannon's Evenness Index</td>
<td>0.880</td>
</tr>
<tr>
<td>Simpson's Evenness Index</td>
<td>0.925</td>
</tr>
<tr>
<td>Modified Simpson's Evenness Index</td>
<td>0.818</td>
</tr>
<tr>
<td>Interspersion/Intra-position Index (%)</td>
<td>73.351</td>
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<tr>
<td>Contagion (%)</td>
<td>32.714</td>
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Processing image: lin.lan
Number of rows, cols: 153, 208
Interior Background Value: 0
Exterior Background Value: 0
Reading 0 bit ERDAS image ... 

... 17020 cells of background exterior to the landscape found

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<tr>
<th>Class</th>
<th>Cells</th>
<th>Patches</th>
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<tr>
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<td>2</td>
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<td>159</td>
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<td>4</td>
<td>1332</td>
<td>172</td>
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<td>5</td>
<td>910</td>
<td>129</td>
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<td>6</td>
<td>2119</td>
<td>82</td>
</tr>
<tr>
<td>9</td>
<td>54</td>
<td>16</td>
</tr>
</tbody>
</table>

Number of classes: 6
Number of patches/Class: 172
Max patch size: 15033 (background/border patch)

**LANDSCAPE INDICES**

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Area (ha)</td>
<td>597.160</td>
</tr>
<tr>
<td>Largest Patch Index (t)</td>
<td>32.903</td>
</tr>
<tr>
<td>Number of patches</td>
<td>675</td>
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<tr>
<td>Patch Density (t/100 ha)</td>
<td>113.989</td>
</tr>
<tr>
<td>Mean Patch Size (ha)</td>
<td>0.955</td>
</tr>
<tr>
<td>Patch Size Standard Dev (ha)</td>
<td>8.004</td>
</tr>
<tr>
<td>Patch Size Coeff of Variation (%)</td>
<td>912.427</td>
</tr>
<tr>
<td>Total Edge (a)</td>
<td>210740.00</td>
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<tr>
<td>Edge Density (a/ha)</td>
<td>305.584</td>
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<tr>
<td>Contrast-Weight Edge Density (a/ha)</td>
<td>NA</td>
</tr>
<tr>
<td>Total Edge Contrast Index (t)</td>
<td>NA</td>
</tr>
<tr>
<td>Mean Edge Contrast Index (t)</td>
<td>NA</td>
</tr>
<tr>
<td>Area-Weighted Mean Edge Contrast (t)</td>
<td>NA</td>
</tr>
<tr>
<td>Landscape Shape Index</td>
<td>21.650</td>
</tr>
<tr>
<td>Mean Shape Index</td>
<td>1.294</td>
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<tr>
<td>Area-Weighted Mean Shape Index</td>
<td>5.145</td>
</tr>
<tr>
<td>Double Log Fractal Dimension</td>
<td>1.419</td>
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<tr>
<td>Mean Patch Fractal Dimension</td>
<td>1.047</td>
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<tr>
<td>Area-Weighted Mean Fractal Dimension</td>
<td>1.217</td>
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<tr>
<td>Total Core Area (ha)</td>
<td>235.160</td>
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<tr>
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<tr>
<td>Core Area Density (t/100 ha)</td>
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<tr>
<td>Mean Core Area 1 (ha)</td>
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</tr>
<tr>
<td>Core Area Standard Dev 1 (ha)</td>
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</tr>
<tr>
<td>Core Area Coef of Variation 1 (t)</td>
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</tr>
<tr>
<td>Mean Core Area 2 (ha)</td>
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<tr>
<td>Core Area Standard Dev 2 (ha)</td>
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<tr>
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<td>NA</td>
</tr>
<tr>
<td>Shannon’s Diversity Index</td>
<td>1.153</td>
</tr>
<tr>
<td>Simpson’s Diversity Index</td>
<td>2.167</td>
</tr>
<tr>
<td>Modified Simpson’s Diversity Index</td>
<td>2.936</td>
</tr>
<tr>
<td>Patch Richness</td>
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<tr>
<td>Patch Richness Density (t/100 ha)</td>
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<tr>
<td>Relative Patch Richness (t)</td>
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<tr>
<td>Shannon’s Evenness Index</td>
<td>0.652</td>
</tr>
<tr>
<td>Simpson’s Evenness Index</td>
<td>0.680</td>
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<tr>
<td>Modified Simpson’s Evenness Index</td>
<td>0.467</td>
</tr>
<tr>
<td>Interspersion/Juxtaposition Index (t)</td>
<td>54.384</td>
</tr>
<tr>
<td>Contegion (t)</td>
<td>51.105</td>
</tr>
</tbody>
</table>
... 282% cells of background exterior to the landscape found

| Class | 1: | 7745 cells, 292 patches |
| Class | 4: | 4252 cells, 488 patches |
| Class | 5: | 2087 cells, 289 patches |
| Class | 6: | 805 cells, 88 patches |
| Class | 9: | 235 cells, 76 patches |

- Number of classes: 5
- Max patches/class: 488
- Max_patch_size: 27354 (background/border patch)

**LANDSCAPE INDICES**

- Total Area (ha): 604.960
- Largest Patch Index (%): 5.177
- Number of patches: 1233
- Patch Density (#/100 ha): 203.815
- Mean Patch Size (ha): 0.423
- Patch Size Standard Dev (ha): 1.985
- Patch Size Coeff of Variation (%): 386.298
- Total Edge (m): 323700.000
- Edge Density (m/ha): 515.077
- Contrast-Weight Edge Density (m/ha): NA
- Total Edge Contrast Index (%): NA
- Mean Edge Contrast Index (%): NA
- Area-Weighted Mean Edge Contrast (%): NA
- Landscape Shape Index: 32.902
- Mean Shape Index: 1.315
- Area-Weighted Mean Shape Index: 2.889
- Double Log Fractal Dimension: 1.460
- Mean Patch Fractal Dimension: 1.051
- Area-Weighted Mean Fractal Dimension: 1.172
- Total Core Area (ha): 140.440
- Number of Core Areas: 374
- Core Area Density (#/100 ha): 61.822
- Mean Core Area 1 (ha): 0.114
- Core Area Standard Dev 1 (ha): 6.807
- Core Area Coeff of Variation 1 (%): 726.146
- Mean Core Area 2 (ha): 0.334
- Core Area Standard Dev 2 (ha): 1.146
- Core Area Coeff of Variation 2 (%): 1289.459
- Total Core Area Index (%): 23.215
- Mean Core Area Index (%): 2.601
- Mean Nearest Neighbor (m): 54.962
- Nearest Neighbor Standard Dev (m): 72.292
- Nearest Neigh Coeff of Variation (%): 131.512
- Mean Proximity Index: NA
- Shannon's Diversity Index: 1.194
- Simpson's Diversity Index: 0.637
- Modified Simpson's Diversity Index: 1.012
- Patch Richness: 5
- Patch Richness Density (#/100 ha): 0.827
- Relative Patch Richness (%): NA
- Shannon's Evenness Index: 0.742
- Simpson's Evenness Index: 0.746
- Modified Simpson's Evenness Index: 0.629
- Interspersion/Juxtaposition Index (%): 65.143
- Contagion (%): 40.807
... 22765 cells of background exterior to the landscape found.

**LANDSCAPE INDICES**

- Total Area (ha): 612.440
- Largest Patch Index (%): 5.471
- Number of patches: 888
- Mean Patch Size (ha): 0.650
- Patch Size Standard Dev (ha): 2.599
- Patch Size Coef of Variation (%): 376.928
- Total Edge (m): 268020.000
- Edge Density (m/ha): 437.927
- Contrast-Weight Edge Density (m/ha): NA
- Total Edge Contrast Index (%): NA
- Mean Edge Contrast Index (%): NA
- Area-Weighted Mean Edge Contrast (%): NA
- Landscape Shape Index: 27.075
- Mean Shape Index: 1.319
- Area-Weighted Mean Shape Index: 2.924
- Double Log Fractal Dimension: 1.427
- Mean Patch Fractal Dimension: 1.051
- Area-Weighted Mean Fractal Dimension: 1.173
- Total Core Area (ha): 200.120
- Number of Core Areas: 307
- Core Area Density (4/100 ha): 50.127
- Mean Core Area (ha): 0.225
- Core Area Standard Dev 1 (ha): 1.335
- Core Area Coef of Variation 1 (%): 592.417
- Mean Core Area 2 (ha): 0.632
- Core Area Standard Dev 2 (ha): 2.209
- Core Area Coef of variation 1 (%): 204.003
- Total Core Area Index (%): 32.676
- Mean Core Area Index (%): 1.884
- Mean Nearest Neighbor (m): 59.383
- Nearest Neighbor Standard Dev (m): 77.948
- Nearest Neighbor Coeff of Variation (%): 131.262
- Mean Proximity Index: NA
- Shannon’s Diversity Index: 1.222
- Simpson’s Diversity Index: 0.672
- Modified Simpson’s Diversity Index: 1.113
- Patch Richness: 7
- Patch Richness Density (4/100 ha): 1.140
- Relative Patch Richness (%): NA
- Shannon’s Evenness Index: 0.580
- Simpson’s Evenness Index: 0.783
- Modified Simpson’s Evenness Index: 0.572
- Interspersion/Interposition Index (%): 55.260
- Contagion (%): 50.042

**Number of rows, cols:** 167, 226
**Interior Background Value:** 0
**Exterior Background Value:** 0
**Reading 8 bit ERDAS image....**
... 20794 cells of background exterior to the landscape found

<table>
<thead>
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<th>Class</th>
<th>1</th>
<th>6424 cells, 202 patches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
<td>2</td>
<td>2579 cells, 122 patches</td>
</tr>
<tr>
<td>Class</td>
<td>4</td>
<td>1227 cells, 290 patches</td>
</tr>
<tr>
<td>Class</td>
<td>5</td>
<td>3024 cells, 281 patches</td>
</tr>
<tr>
<td>Class</td>
<td>6</td>
<td>1143 cells, 133 patches</td>
</tr>
<tr>
<td>Class</td>
<td>9</td>
<td>394 cells, 87 patches</td>
</tr>
</tbody>
</table>

Number of classes: 6
max patches/class: 290
max_patch_size: 2014 (background/border patch)

LANDSCAPE INDICES
- Total Area (ha): 592,000
- Largest Patch Index (%): 18.399
- Number of patches: 1115
- Patch Density (#/100 ha): 185.245
- Mean Patch Size (ha): 0.531
- Patch Size Standard Dev (ha): 3.731
- Patch Size Coeff of Variation (%): 702.719
- Total Edge (m): 262500.000
- Edge Density (m/ha): 443.412
- Contrast-Weight Edge Density (m/ha): NA
- Total Edge Contrast Index (%): NA
- Mean Edge Contrast Index (%): NA
- Area-Weighted Mean Edge Contrast (%): NA
- Landscape Shape Index: 26.972
- Mean Shape Index: 1.147
- Area-Weighted Mean Shape Index: 1.326
- Double Log Fractal Dimension: 1.410
- Mean Patch Fractal Dimension: 1.041
- Area-Weighted Mean Fractal Dimension: 1.177
- Total Core Area (ha): 198.280
- Number of Core Areas: 262
- Core Area Density (#/100 ha): 44.287
- Core Core Area 1 (%) : 0.178
- Core Area Standard Dev 1 (ha): 7.251
- Core Area Coeff of Variation 1 (%): 125.115
- Core Core Area 2 (%) : 0.177
- Core Area Standard Dev 2 (ha): 4.354
- Core Area Coeff of Variation 2 (%): 135.708
- Total Core Area Index (%): 33.491
- Mean Core Area Index (%): 2.432
- Mean Nearest Neighbor (m): 63.303
- Nearest Neighbor Standard Dev (m): 85.044
- Nearest Neigh Coeff of Variation (%): 172.616
- Mean Proximity Index: NA
- Shannon's Diversity Index: 1.492
- Simpson's Diversity Index: 0.726
- Modified Simpson's Diversity Index: 1.293
- Patch Richness: 6
- Patch Richness Density (#/100 ha): 1.14
- Relative Patch Richness (%): NA
- Shannon's Evenness Index: 0.831
- Simpson's Evenness Index: 0.871
- Modified Simpson's Evenness Index: 0.722
- Interspersion/Justposition Index (%): 80.776
- Contagion (%): 38.659
Sin

Processing Image: Sin.jpg
Number of rows, cols: 184, 214
Interior Background Value: 0
Exterior Background Value: 0
Reading 8 bit ERDAS Image ....

... 24516 cells of background exterior to the landscape found

<table>
<thead>
<tr>
<th>Class</th>
<th>Total Area (ha)</th>
<th>Largest Patch Index (%)</th>
<th>Number of patches</th>
<th>Patch Density (#/100 ha)</th>
<th>Mean Patch Size (ha)</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>3844 cells, 263 patches</td>
<td>4.401</td>
<td>1067</td>
<td>182.861</td>
<td>0.247</td>
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<tr>
<td>2</td>
<td>39 cells, 16 patches</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2428 cells, 288 patches</td>
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<tr>
<td>4</td>
<td>3018 cells, 242 patches</td>
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<td>5</td>
<td>3653 cells, 178 patches</td>
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<tr>
<td>6</td>
<td>1579 cells, 102 patches</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Number of classes: 6
max patches/class: 288
max_patch_size: 22237 (background/border patch)

LANDSCAPE INDICES
Total Area (ha): 594.440
Largest Patch Index (%): 4.401
Number of patches: 1067
Patch Density (#/100 ha): 182.861
Mean Patch Size (ha): 0.247

Patch Size Standard Dev (ha): 1.850
Patch Size Coeff of Variation (%): 338.260
Total Edge (m): 307520.000
Edge Density (#/ha): 517.327

Contrast-Weight Edge Density (#/ha): NA
Total Edge Contrast Index (%): NA
Mean Edge Contrast Index (%): NA
Area-Weighted Mean Edge Contrast (%): NA

Landscape Shape Index: 31.533
Mean Shape Index: 1.336
Area-Weighted Mean Shape Index: 2.844
Double Log Fractal Dimension: 1.452
Mean Patch Fractal Dimension: 1.294
Area-Weighted Mean Fractal Dimension: 1.177
Total Core Area (ha): 142.290
Number of Core Areas: 371
Core Area Density (#/106 ha): 62.412
Mean Core Area (ha): 0.151
Core Area Standard Dev 1 (ha): 0.761
Core Area Coeff of Variation 1 (%): 581.142
Mean Core Area 2 (ha): 0.384
Core Area Standard Dev 2 (ha): 1.284
Core Area Coeff of Variation 2 (%): 945.901
Total Core Area Index (%): 23.935
Mean Core Area Index (%): 3.173
Mean Nearest Neighbor (m): 58.377
Nearest Neighbor Standard Dev (m): 91.412
Nearest Neighbor Coeff of Variation (%): 129.800

Mean Proximity Index: NA
Shannon's Diversity Index: 1.576
Simpson's Diversity Index: 0.783
Modified Simpson's Diversity Index: 3.526
Patch Richness: 9
Patch Richness Density (#/100 ha): 1.009
Relative Patch Richness (%): NA
Shannon's Evenness Index: 0.879
Simpson's Evenness Index: 0.940
Modified Simpson's Evenness Index: 0.893
Interoperatio/Jouxtaposition Index (%): 64.664
Contagion (%): 25.982
... 19554 cells of background exterior to the landscape found

<table>
<thead>
<tr>
<th>Class</th>
<th># cells</th>
<th># patches</th>
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<td>50</td>
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<tr>
<td>2</td>
<td>1921</td>
<td>104</td>
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<td>3</td>
<td>209</td>
<td>68</td>
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<td>4</td>
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<td>179</td>
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<tr>
<td>5</td>
<td>5336</td>
<td>117</td>
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<tr>
<td>6</td>
<td>318</td>
<td>25</td>
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<tr>
<td>7</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>52</td>
<td>15</td>
</tr>
</tbody>
</table>

number of classes: 8
max patches/class: 179
max_patch_size: 17415 (background/border patch)

LANDSCAPE INDICES

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Total Area (ha)</td>
<td>592.560</td>
</tr>
<tr>
<td>Largest Patch Index (%)</td>
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</tr>
<tr>
<td>Number of patches</td>
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</tr>
<tr>
<td>Patch Density (#/100 ha)</td>
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</tr>
<tr>
<td>Mean Patch Size (ha)</td>
<td>1.070</td>
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<tr>
<td>Patch Size Standard Dev (ha)</td>
<td>4.774</td>
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<tr>
<td>Patch Size Coeff of Variation (%)</td>
<td>41.636</td>
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<tr>
<td>Total Edge (m)</td>
<td>198380.000</td>
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<tr>
<td>Edge Density (#/ha)</td>
<td>354.765</td>
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<tr>
<td>Contrast-Weight Edge Density (#/ha)</td>
<td>NA</td>
</tr>
<tr>
<td>Total Edge Contrast Index (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Mean Edge Contrast Index (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Area-Weighted Mean Edge Contrast (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Landscape Shape Index</td>
<td>20.374</td>
</tr>
<tr>
<td>Mean Shape Index</td>
<td>1.326</td>
</tr>
<tr>
<td>Area-Weighted Mean Shape Index</td>
<td>3.576</td>
</tr>
<tr>
<td>Double Log Fractal Dimension</td>
<td>1.401</td>
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<tr>
<td>Mean Patch Fractal Dimension</td>
<td>1.050</td>
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<tr>
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<tr>
<td>Mean Core Area 1 (ha)</td>
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<tr>
<td>Core Area Standard Dev 1 (ha)</td>
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<td>Core Area Coeff of Variation 1 (%)</td>
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<td>1.160</td>
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<tr>
<td>Core Area Standard Dev 2 (ha)</td>
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<td>Mean Core Area Index</td>
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<td>Mean Nearest Neighbor (a)</td>
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<tr>
<td>Nearest Neighbor Standard Dev (a)</td>
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<tr>
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<tr>
<td>Shannon's Diversity Index</td>
<td>1.194</td>
</tr>
<tr>
<td>Simpson's Diversity Index</td>
<td>0.639</td>
</tr>
<tr>
<td>Modified Simpson's Diversity Index</td>
<td>1.019</td>
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<tr>
<td>Patch Richness</td>
<td>8</td>
</tr>
<tr>
<td>Patch Richness Density (#/100 ha)</td>
<td>1.350</td>
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<tr>
<td>Relative Patch Richness (%)</td>
<td>NA</td>
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<tr>
<td>Shannon's Evenness Index</td>
<td>0.574</td>
</tr>
<tr>
<td>Simpson's Evenness Index</td>
<td>0.730</td>
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<tr>
<td>Modified Simpson's Evenness Index</td>
<td>0.490</td>
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<tr>
<td>Interspersion/Deposition Index (%)</td>
<td>43.358</td>
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<tr>
<td>Contigion (%)</td>
<td>58.653</td>
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... 5110 cells of background exterior to the landscape found

<table>
<thead>
<tr>
<th>Class</th>
<th>1:</th>
<th>6519 cells, 139 patches</th>
<th>Class 6: 766 cells, 56 patches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
<td>2:</td>
<td>886 cells, 145 patches</td>
<td>Class 7: 145 cells, 53 patches</td>
</tr>
<tr>
<td>Class</td>
<td>4:</td>
<td>2959 cells, 223 patches</td>
<td><strong>LANDSCAPE INDICES</strong></td>
</tr>
<tr>
<td>Class</td>
<td>5:</td>
<td>3488 cells, 207 patches</td>
<td>Total Area (ha): 590.520</td>
</tr>
<tr>
<td>Class</td>
<td>6:</td>
<td>766 cells, 56 patches</td>
<td>Largest Patch Index(t): 23.726</td>
</tr>
<tr>
<td>Class</td>
<td>9:</td>
<td>145 cells, 53 patches</td>
<td>Number of patches: 823</td>
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</table>

**number of classes:** 6

**Total Core Area (ha):** 193.000

**Core Area Density (#/100 ha):** 54.129

**Mean Core Area 1 (ha):** 0.235

**Core Area Standard Dev 1 (ha):** 0.200

**Core Area Coeff of Variation 1 (%):** 136.856

**Mean Core Area 2 (ha):** 0.599

**Core Area Standard Dev 2 (ha):** 5.107

**Core Area Coeff of Variation 2 (%):** 2177.101

**Total Core Area Index (%):** 32.683

**Mean Core Area Index (%):** 3.461

**Mean Nearest Neighbor (a):** 51.355

**Nearest Neighbor Standard Dev (a):** 56.224

**Nearest Neighbor Coeff of Variation (%):** 109.485

**Mean Proximity Index:** NA

**Shannon’s Diversity Index:** 1.392

**Simpson’s Diversity Index:** 0.703

**Modified Simpson’s Diversity Index:** 1.213

**Patch Richness:**

**Patch Richness Density (#/100 ha):** 1.915

**Relative Patch Richness (%):** NA

**Shannon’s Evenness Index:** 0.777

**Simpson’s Evenness Index:** 0.841

**Modified Simpson’s Evenness Index:** 0.677

**Interp-patch/Intrap-patch Index (%):** 74.002

**Contagion (%):** 37.455
... 13677 cells of background exterior to the landscape found

<table>
<thead>
<tr>
<th>Class</th>
<th># cells</th>
<th># patches</th>
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<tbody>
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<td>2</td>
<td>1869</td>
<td>193</td>
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<td>2070</td>
<td>236</td>
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<td>7163</td>
<td>174</td>
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<td>1555</td>
<td>154</td>
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<td>6</td>
<td>389</td>
<td>66</td>
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</table>

Number of classes: 6  
max patches/class: 274

max_patch_size: 9823 (background/border patch)

LANDSCAPE INDICES

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
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<tbody>
<tr>
<td>Total Area (ha)</td>
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<tr>
<td>Largest Patch Index</td>
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<tr>
<td>Number of patches</td>
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</tr>
<tr>
<td>Patch Density (#/100 ha)</td>
<td>184.320</td>
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<tr>
<td>Mean Patch Size (ha)</td>
<td>7.263</td>
</tr>
<tr>
<td>Patch Size Standard Dev (ha)</td>
<td>3.836</td>
</tr>
<tr>
<td>Patch Size Coeff of Variation (%)</td>
<td>7.11032</td>
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<tr>
<td>Total Edge (m)</td>
<td>253240.000</td>
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<tr>
<td>Edge Density (m/ha)</td>
<td>419.363</td>
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<tr>
<td>Contrast-Weight Edge Density (m/ha)</td>
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<tr>
<td>Total Edge Contrast Index (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Mean Edge Contrast Index (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Area-Weighted Mean Edge Contrast (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Landscape Shape Index:</td>
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<tr>
<td>Mean Shape Index:</td>
<td>1.280</td>
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<tr>
<td>Area-Weighted Mean Shape Index:</td>
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<tr>
<td>Double Log Fractal Dimension:</td>
<td>1.428</td>
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<tr>
<td>Mean Patch Fractal Dimension:</td>
<td>1.047</td>
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<td>Area-Weighted Mean Fractal Dimension:</td>
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<tr>
<td>Core Area Standard Dev 1 (ha):</td>
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<tr>
<td>Core Area Coeff of Variation 1 (%):</td>
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<td>Core Area Coeff of Variation 2 (%):</td>
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<td>Total Core Area Index (%):</td>
<td>28.041</td>
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<td>Mean Core Area Index (%):</td>
<td>2.779</td>
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<tr>
<td>Mean Nearest Neighbor (m):</td>
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<tr>
<td>Mean Proximity Index:</td>
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<tr>
<td>Shannon's Diversity Index:</td>
<td>1.467</td>
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<tr>
<td>Simpson's Diversity Index:</td>
<td>0.702</td>
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<tr>
<td>Modified Simpson's Diversity Index:</td>
<td>1.220</td>
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<tr>
<td>Patch Richness:</td>
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<tr>
<td>Patch Richness Density (#/100 ha):</td>
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</tr>
<tr>
<td>Relative Patch Richness (%):</td>
<td>NA</td>
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<tr>
<td>Shannon's Evenness Index:</td>
<td>0.819</td>
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<tr>
<td>Simpson's Evenness Index:</td>
<td>0.642</td>
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<tr>
<td>Modified Simpson's Evenness Index:</td>
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<tr>
<td>Interdispersion/Interspecificity Index (%):</td>
<td>78.431</td>
</tr>
<tr>
<td>Contagion (%):</td>
<td>35.343</td>
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</tbody>
</table>

...
LANDSCAPE INDICES
Total Area (ha): 591.200
Largest Patch Index (%): 3.675
Number of patches: 1155
Patch Density (#/100 ha): 195.431
Mean Patch Size (ha): 0.537
Patch Size Standard Dev (ha): 1.446
Patch Size Coeff of Variation (%): 282.635
Total Edge (m): 27820.000
Edge Density (m/ha): 470.065
Contrast-Weight Edge Density (m/ha): NA
Total Edge Contrast Index (%): NA
Mean Edge Contrast Index (%): NA
Area-Weighted Mean Edge Contrast (%): NA
Landscape Shape Index: 28.570
Mean Shape Index: 1.330
Area-Weighted Mean Shape Index: 1.550
Double Log Fractal Dimension: 1.149
Mean Patch Fractal Dimension: 1.054
Area-Weighted Mean Fractal Dimension: 1.156
Total Core Area (ha): 120.000
Number of Core Areas: 415
Core Area Density (#/100 ha): 70.200
Mean Core Area 1 (ha): 0.104
Core Area Standard Dev 1 (ha): 0.342
Mean Coef of Variation 1 (%): 52.006
Mean Core Area 2 (ha): 0.289
Core Area Standard Dev 2 (ha): 0.826
Mean Coef of Variation 2 (%): 84.872
Total Core Area Index (%): 20.205
Mean Core Area Index (%): 3.358
Mean Nearest Neighbor (%): 30.214
Nearest Neighbor Standard Dev (m): 60.217
Nearest Neighbor Coef of Variation (%): 179.724
Mean Proximity Index: NA
Shannon’s Diversity Index: 1.265
Simpson’s Diversity Index: 0.396
Modified Simpson’s Diversity Index: 1.736
Patch Richness: 6
Patch Richness Density (#/100 ha): 1.911
Relative Patch Richness (%): NA
Shannon’s Evenness Index: 0.742
Simpson’s Evenness Index: 0.830
Modified Simpson’s Evenness Index: 0.665
Interspersion/Justposition Index (%): 66.674
Contagion (%): 37.042
... 7296 cells of background exterior to the landscape found

<table>
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<tr>
<th>Class</th>
<th>Cells</th>
<th>Patches</th>
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<td>5550</td>
<td>356</td>
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<tr>
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<td>2385</td>
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<td>517</td>
<td>76</td>
</tr>
<tr>
<td>9</td>
<td>531</td>
<td>76</td>
</tr>
</tbody>
</table>

Number of classes: 5
max patches/class: 356
max_patch_size: 2140 (background/border patch)

<table>
<thead>
<tr>
<th>LANDSCAPE INDICES</th>
<th>Value</th>
</tr>
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<tbody>
<tr>
<td>Total Area (ha)</td>
<td>603.560</td>
</tr>
<tr>
<td>Largest Patch Index (%)</td>
<td>4.875</td>
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<tr>
<td>Number of patches</td>
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<td>Patch Size Standard Dev (ha)</td>
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<tr>
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<td>Total Edge (m)</td>
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<td>Edge Density (a/ha)</td>
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<tr>
<td>Contrast-Weight Edge Density (a/ha)</td>
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<tr>
<td>Total Edge Contrast Index (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Mean Edge Contrast Index (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Area-Weighted Mean Edge Contrast (%)</td>
<td>NA</td>
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<tr>
<td>Landscape Shape Index</td>
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<tr>
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<td>1.325</td>
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<tr>
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<td>1.444</td>
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<td>1.051</td>
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<tr>
<td>Area-Weighted Mean Fractal Dimension</td>
<td>1.187</td>
</tr>
<tr>
<td>Total Core Area (ha)</td>
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</tr>
<tr>
<td>Number of Core Areas</td>
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</tr>
<tr>
<td>Core Area Density (#/100 ha)</td>
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<tr>
<td>Mean Core Area 1 (ha)</td>
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<tr>
<td>Core Area Standard Dev 1 (ha)</td>
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<td>NA</td>
</tr>
<tr>
<td>Shannon's Diversity Index</td>
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<tr>
<td>Simpson's Diversity Index</td>
<td>0.677</td>
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<td>Modified Simpson's Diversity Index</td>
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<tr>
<td>Simpson's Evenness Index</td>
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<tr>
<td>Modified Simpson's Evenness Index</td>
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<td>Interspersion/Interspersion Index (%)</td>
<td>64.294</td>
</tr>
<tr>
<td>Contagion (%)</td>
<td>35.251</td>
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</table>
... 10280 cells of background exterior to the landscape found

<table>
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<tr>
<th>Class</th>
<th>Cells</th>
<th>Patches</th>
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<td>262</td>
<td>52</td>
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<tr>
<td>3</td>
<td>1973</td>
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<td>293</td>
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<td>1258</td>
<td>177</td>
</tr>
</tbody>
</table>

Number of classes: 6
max patches/class: 344
max_patch_size: 5430 (background/border patch)

**LANDSCAPE INDICES**

- Total Area (ha): 599.720
- Largest Patch Index(t): 4.182
- Number of patches: 3352
- Patch Density ($/100$ ha): 225.479
- Mean Patch Size (ha): 1.258
- Patch Size Standard Dev (ha): 283.500
- Patch Size Coeff of Variation (%): 298.460
- Total Edge (m): 497.466
- Edge Density (m/ha): NA
- Contrast-Weight Edge Density (m/ha): NA
- Total Edge Contrast Index (%): NA
- Mean Edge Contrast Index (%): NA
- Area-Weighted Mean Edge Contrast (%): NA
- Landscape Shape Index: 30.469
- Mean Shape Index: 1.319
- Area-Weighted Mean Shape Index: 2.390
- Double Log Fractal Dimension: 1.451
- Mean Patch Fractal Dimension: 1.053
- Area-Weighted Mean Fractal Dimension: 1.149
- Total Core Area (ha): 111.640
- Number of Core Areas: 206
- Core Area Density ($/100$ ha): 66.631
- Mean Core Area (ha): 0.203
- Core Area Standard Dev (ha): 0.504
- Core Area Coeff of Variation (%): 586.321
- Mean Core Area (ha): 0.202
- Core Area Standard Dev (ha): 0.910
- Core Area Coeff of Variation (%): 152.019
- Total Core Area Index (%): 18.165
- Mean Core Area Index (%): 2.964
- Mean Nearest Neighbor (m): 43.716
- Nearest Neighbor Standard Dev (m): 50.273
- Nearest Neighbor Coeff of Variation (%): 115.000
- Mean Proximity Index: NA
- Shannon's Diversity Index: 1.591
- Simpson's Diversity Index: 0.779
- Modified Simpson's Diversity Index: 1.509
- Patch Richness: 6
- Patch Richness Density ($/100$ ha): 1.000
- Relative Patch Richness (%): NA
- Shannon's Evenness Index: 0.288
- Simpson's Evenness Index: 0.935
- Modified Simpson's Evenness Index: 0.842
- Interspersion/Justiocation Index (%): 77.824
- Contegion (%): 28.517
Processing image: 6er.len
Number of rows, cols: 135, 223
Interior Background Value: 0
Exterior Background Value: 1
Reading 8 bit ERDAS image ....

... 14762 cells of background exterior to the landscape found

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Number of clusters: 7
max patches/class: 306
max_patch_size: 13417 (background/border patch)

**LANDSCAPE INDICES**

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**Land Area (ha):** 128.00
### LANDSCAPE INDICES

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LANDSCAPE INDICES

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### LANDSCAPE INDICES

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**LANDSCAPE INDICES**

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*Note: The data provided is a sample of the landscape indices calculated for a specific area.*
### LANDSCAPE INDICES

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<tr>
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<td>Mean Edge Contrast Index (%)</td>
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LANDSCAPE INDICES

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Edge Dist: 20.0 Max Patch Type Possible: NA Background: 0
No ID Image Will Be Output.
Image Does Not Include a Landscape Border
Proportion of Boundary/Background to Count as Edge: 1.00
Diagonals Used: Proximity Indices Not Calculated
Nearest Neighbor Cals
Do not Write Patch Indices: Do Not Write Class Indices

**LANDSCAPE INDICES**

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**LANDSCAPE INDICES**

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**Note:** The document appears to be a report or an output from a geographic information system (GIS) analysis, detailing various landscape indices and metrics.
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<tr>
<td>Mean Edge Contrast Index (%)</td>
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**LANDSCAPE INDICES**

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No 10 Image Will Be Output
Image Does Not Include a Landscape Border
Proportion of Boundary/Background to Count as Edge: 1.00
Diagonals Used: Proximity Indices Not Calculated
Nearest Neighbor Calc
Do not Write Patch Indices: Do Not Write Class Indices

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### Landscape Indices

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### LANDSCAPE INDICES

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LANDSCAPE INDICES

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### LANDSCAPE INDICES

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Largest Patch Index(%): 16.350
Number of patches: 196
Patch Density (1/100 ha): 125.928
Mean Patch Size (ha): 0.794
Patch Size Standard Dev (ha): 2.675
Patch Size Coeff of Variation (%): 36.853
Total Edge (a): 55500.000
Edge Density (a/ha): 356.592
Contrast-Weight Edge Density (a/ha): NA
Total Edge Contrast Index (%): NA
Mean Edge Contrast Index (%): NA
Area-Weighted Mean Edge Contrast (%): NA
Landscape Shape Index: 11.122
Mean Shape Index: 1.281
Area-Weighted Mean Shape Index: 2.508
Double Log Fractal Dimension: 1.370
Mean Patch Fractal Dimension: 1.047
Area-Weighted Mean Fractal Dimension: 1.149
Total Core Area (ha): 48.440
Number of Core Areas: 61
Core Area Density (a/100 ha): 37.628
Mean Core Area (ha): 0.350
Core Area Standard Dev 1 (ha): 1.731
Core Area Coeff of Variation 1 (%): 495.620
Mean Core Area 2 (ha): 1.536
Core Area Standard Dev 2 (ha): 3.417
Core Area Coeff of Variation 2 (%): 98.859
Total Core Area Index (%): 44.102
Mean Core Area Index (%): 4.446
Mean Nearest Neighbor (%): 80.311
Nearest Neighbor Standard Dev (a): 141.156
Nearest Neigh Coef of Variation (%): 171.726
Mean Proximity Index: NA
Shannon's Diversity Index: 1.775
Simpson's Diversity Index: 0.653
Modified Simpson's Diversity Index: 1.058
Patch Richness: 3
Patch Richness Density (a/100 ha): 5.140
Relative Patch Richness (%): NA
Shannon's Evenness Index: 0.613
Simpson's Evenness Index: 0.746
Modified Simpson's Evenness Index: 0.507
Interdispersion/Coordination Index (%): 50.719
Contagion (%): 56.781
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<td>Interception/Intercalposition Index (%):</td>
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<td>Contagion (%)</td>
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### Landscape Indices

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**Notes:**
- Proportion of boundary/background to count as edge: 1.00
- Diagonals used: Proximity Indices Not Calculated
- Nearest Neighbor Calculations
- Do not write patch indices: Do Not Write Class Indices
... 456351 cells of background exterior to the landscape found

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Number of classes: 11

max patches/class: 1496
max_\_patch_\_size: 447848 (background/border patch)

**CLASS 1**

CLASS INDICES

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**CLASS INDICES**

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**CIASS3**

### CLASS INDICES

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**CIASS6**

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**Class Indices**

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### Class 10

**Class Indices**

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| Largest Patch Index (%): | 0.001 |
| Number Patches: | 1 |
| Patch Density (#/100 ha): | 0.026 |
| Mean Patch Size (ha): | 0.040 |
| Patch Size SD (ha): | 0.000 |
| Patch Size CV (%): | 0.000 |
| Total Edge (m): | 80.000 |
| Con-wght Edge Den (m/ha): | NA |
| Total Edge Contrast (%): | NA |
| Mean Edge Contrast (%): | NA |
| Area-weighted Mean Edge Con(%): | NA |
| Landscape Shape Index: | 40.268 |
| Mean Shape Index: | 1.000 |
| Area-weighted Mean Shape: | 1.000 |
| Mean Patch Fractal: | 1.000 |
| Area-weighted Mean Fractal: | 1.000 |
| Core % of Landscape (%): | 0.000 |
| Core Area 1 (ha): | 0.000 |
| Core Area SD 1 (ha): | 0.000 |
| Core Area CV 1 (%): | 0.000 |
| Core Area SD 2 (ha): | 0.000 |
| Core Area CV 2 (%): | 0.000 |
| Total Core Area Index (%): | 0.000 |
| Mean Core Area Index (%): | 0.000 |
| Core Area Den (#/100 ha): | 0.000 |
| Mean Core Area 1 (ha): | 0.000 |
| Core Area SD 1 (ha): | 0.000 |
| Core Area CV 1 (%): | 0.000 |
| Core Area SD 2 (ha): | 0.000 |
| Core Area CV 2 (%): | 0.000 |
| Total Core Area Index (%): | 0.000 |
| Mean Core Area Index (%): | 0.000 |
| Near Neighbor Dist (m): | 0.000 |
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| Nearest Neighbor CV (%): | 0.000 |
| Mean Prox Index: | NA |
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... 404269 cells of background exterior to the landscape found

Class 1: 33164 cells, 1760 patches
Class 2: 7016 cells, 784 patches
Class 3: 375 cells, 7 patches
Class 4: 24027 cells, 2109 patches
Class 5: 41673 cells, 2503 patches
Class 6: 26535 cells, 1795 patches
Class 8: 156 cells, 17 patches
Class 9: 7053 cells, 805 patches
Class 10: 6528 cells, 181 patches
Class 12: 755 cells, 19 patches

Number of classes: 10
Max patches/class: 2503
Max_patch_size: 360767 (background/border patch)

CLASS 1 (Oakbrush)

CLASS INDICES

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### Class Area (ha):

- Class 2: 280.640
- Class 3: 15.000
### Class 4 (Oak-Sagebrush Mix)

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<td>Area-Wt Mean Edge Con (%)</td>
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### CLASS 9
#### CLASS INDICES

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### CLASS 10
#### CLASS INDICES

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<tr>
<td>Mean Patch Size (ha):</td>
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<tr>
<td>Patch Size Standard Dev (ha):</td>
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<tr>
<td>Patch Size Coeff of Variation (%):</td>
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<tr>
<td>Total Edge (m):</td>
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<tr>
<td>Edge Density (m/ha):</td>
<td>420.398</td>
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<tr>
<td>Contrast-Weight Edge Density (m/ha):</td>
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<tr>
<td>Total Edge Contrast Index (%):</td>
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<tr>
<td>Mean Edge Contrast Index (%):</td>
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<tr>
<td>Area-Weighted Mean Edge Contrast (%):</td>
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<td>Landscape Shape Index:</td>
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<td>Mean Shape Index:</td>
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<td>Area-Weighted Mean Shape Index:</td>
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<td>Double Log Fractal Dimension:</td>
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<td>Mean Patch Fractal Dimension:</td>
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<td>Area-Weighted Mean Fractal Dimension:</td>
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<td>Total Core Area (ha):</td>
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<td>Core Area Density (#/100 ha):</td>
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<td>Mean Core Area 1 (ha):</td>
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<td>Core Area Standard Dev 1 (ha):</td>
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<td>Core Area Coeff of Variation 1 (%):</td>
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<td>Mean Core Area 2 (ha):</td>
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